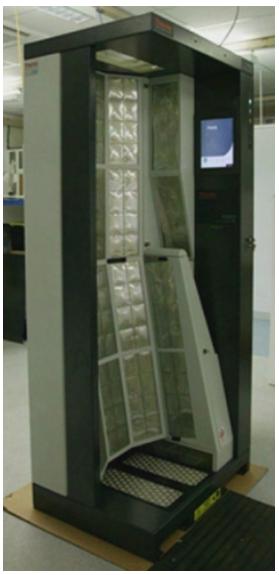
MANUAL-IPCM12

INSTALLED PERSONNEL CONTAMINATION MONITOR

Thermo Fisher Scientific

iPCM12

June 2010



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NOTICE

iPCM12

WARRANTY AND LIABILITY

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IMPORTANT NOTICE

All units produced after the 1st January 1996 must by law conform to the rules and regulations governing Electro-magnetic compatibility (EMC). In order to meet the requirements and CE mark the units described in this manual, any maintenance carried out must ensure the correct re-assembly of all parts, especially the earth straps. Furthermore, particular attention should be made to the correct mounting of the mains filter.

WARNING

Personnel may trigger an alarm on an iPCM12, who have recently been subject to radiotherapy treatments that involve the injection or ingestion of radioactive isotopes. The monitor is not able to distinguish these isotopes from those generated via on on-site process. However the monitor does have the ability to indicate the presence of low energy photon emitting isotopes, which are typical of radiotherapy treatments.

The iPCM12 monitor should be primarily used for monitoring personnel. Other objects and articles should be monitored with a monitor that is designed for their monitoring, such as a SAM12.

However if articles are passed through the monitor, operational procedures should contain warnings regarding inappropriate articles.

These items may include:

- Articles containing liquids
- Articles with significant shielding
- Articles containing large magnets
- Articles with known radioactive content

Articles containing liquids may have different release criteria. Articles of large weight or significant shielding may require different procedures requiring Health Physics intervention. Articles with a magnetic pull of more than four pounds may influence the accuracy of the monitor.

The iPCM12 weighs between 0.75 and 1 ton. The monitor should only be installed and used on a suitably robust and stable base. The monitor should never be moved with the lead installed.

WARNING AGAINST IMPROPER USE

The protection provided by this equipment may be impaired if used in a manner not specified by the manufacturer. The user must adhere to all the safety precautions noted overleaf and to individual warnings contained within this manual.

WARNING SYMBOLS:

The following is an explanation of the warning symbols seen on the iPCM12. Please read this information before using and/or maintaining this equipment.

As seen on the top of the iPCM12 frame and FHT681 covers.

	CAUTION: **Isolate the mains supply and wait one minute before removing this cover.**

	CAUTION: **Isolate HV supply to the printed circuit board before removing cover. With power connected and unit switched on, a max. voltage of +1500V DC with a maximum short circuit power of 825 milliwatts is present.**

	CAUTION: **Risk of electric shock.**

WEEE COMPLIANCE:

This product is required to comply with the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive 2002/96/EC. It is marked with the following symbol:

Thermo Fisher Scientific has contracted with one or more recycling/disposal companies in each EU Member State, and this product should be disposed of or recycled through them. Further information on Thermo Fisher's compliance with these Directives, the recyclers in your country, and information on Thermo Fisher products which may assist the detection of substances subject to the RoHS Directive are available at www.thermofisher.com/WEEERoHS

	CAUTION: THIS INSTRUMENT UTILIZES GAS FLOW PROPORTIONAL COUNTERS. MIXED GAS, ARGON/METHANE (ARCH4), IS THE RECOMMENDED COUNTING GAS. ITS MATERIAL SAFETY DATA SHEET (MSDS) IS REFERENCED IN CHAPTER 13, DRAWING APPENDIX AND CONTAINED ON THE MANUAL CD-ROM. CARE SHOULD BE TAKEN TO FOLLOW ALL RECOMMENDATIONS ON THE MSDS WHEN HANDLING THIS GAS.

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Manual Revision History

Issue	Date	Name	Section(s)	Revision comments	Approval
1.0	May 2010	L DeLonais / C Hills	All	Initial Release	M Pottinger
2.0	June 2010	L DeLonais	WEEE/RohS statement, add P-10_MSDS to Chapter 13	Rev 02	J. Menge

Foreword

Throughout this document the term **“HEALTH PHYSICIST”** (HP) is used extensively. It refers to the Person, Persons, or Team responsible for setting up day-to-day running and maintenance of the **iPCM12**. This may be an Instrument Maintenance Engineer, Radiation Safety Officer, local “Competent Person”, Departmental Manager or any other Responsible Person. The **“HEALTH PHYSICIST”** is the highest-level security role, uniquely responsible for setting and maintaining all lower order passwords. The HP would normally be responsible for installing and setting up the **iPCM12**, calibrating for user-defined nuclides, programming operating parameters and verifying correct operation of the instrument.

The term **“TECHNICIAN”** is used to refer to the personnel who normally repair and maintain the instrument in working condition. IMP personnel are designated to this role.

Personnel who are general users of the system and normally carry out routine diagnostic and test functions are allocated to the **“THERMOFISHER”** role.

The term **“USER”** refers to anybody associated with or operating the instrument in any way.

For more information on which menu options are available, see Menu Roles (page 5-7).

Chapter 1 Introduction

Installed Personnel Contamination Monitor

iPCM12 Overview

The Installed Personnel Contamination Monitor type iPCM12 is designed for controlled detection of radioactive contamination on all parts of the body and clothing. Should contamination exceed an Alarm Level (AL), an audible alarm is given and a visual indication of the location and severity of contamination is displayed.

Surface alpha and beta contamination are detected simultaneously using up to 24 large-area gas flow proportional detectors. Each detector is internally divided into four separate detection channels, creating up to 96 individual counting zones and giving maximum detection sensitivity and background rejection. A pair of detectors is used to detect contamination on each hand and another pair monitors the sole of each foot individually. Two more detectors cover the side of foot (optional) and top of shoes. Two detectors provide coverage for the side of legs and an additional three detectors provide coverage for the upper arm, shoulder, back of shoulder (optional) and side of head. Another twelve detectors, arranged in three closely positioned vertical arrays configured in a half-hexagon, are used with an optional overhead detector to detect contamination on the rest of the body.

Optionally, large area plastic scintillation detectors and lead shielding can be fitted to simultaneously detect gamma contamination. Two vertical arrays with three detectors each are arranged behind the gas proportional detectors to measure contamination on the body. Two separate detectors are used to check for contamination on the hands and soles of shoes. Optionally, two other detectors can be fitted in place of gas flow detectors to detect gamma on the top and side of the head. The body and sole of foot gamma detectors require the optional closed cabinet extension to be fitted to accommodate the lead shielding.

The gas-flow detector size and the mechanical configuration of the hand, foot, and body detector geometry has been carefully chosen for optimum detection efficiency.

The body is monitored in two separate stages. In the first stage, forward measurement, the whole front of the body, top of head,

right hand, side of the right leg and right arm, shoulder, and side of head are monitored. Also, the soles of both feet, the tops of both shoes and the side of the right foot are simultaneously measured for alpha and beta contamination. If optional scintillation detectors are fitted, the front of the body, top and right side of head, right hand, and right foot are simultaneously measured for gamma contamination.

In the second stage, reverse measurement, the whole back of the body, top of head, left hand, side of the left leg, left arm, shoulder, and side of head are monitored. Also, the soles of both feet and the side of the left foot are simultaneously measured for alpha and beta contamination. If optional scintillation detectors are fitted, the back of the body, top and left side of head, left hand, and left foot are simultaneously measured for gamma contamination.

Electronics and control are provided by a central ETX micro-PC interfacing with distributed intelligent processing at the detector nodes via an “X-Channel” network. The system is programmed to take into account the statistical variables associated with contamination monitoring and includes intelligent auto-recovering self-testing routines. System operational parameters and options are user programmable by means of a password protected LCD touch-screen. Multiple level password protection prevents unauthorized access to system operational and diagnostic parameters.

Detectors operate on low flow-rate Argon/Methane or optionally Argon/CO_2 gas mixtures. Setting of gas purge and operational flows is by manual valves while flow switching and flow measurement is electronic. Automatic start-up purging monitors detector stability and switches to normal, low operational flow when all detector backgrounds are stable. User programmable high and low flow-rate alarms and automatic leak detection provides early puncture alerts.

Each detection channel has the following five “count windows”: low-energy beta, high-energy beta, low-energy alpha, high-energy alpha, and Radon. Prior to monitoring operation, the background counts for each detection channel count window are accrued over a preset background monitoring time. When an operator is correctly positioned in the monitor, all detector channels are integrated over the optimum measurement period, which is dynamically determined by the central processor to achieve the programmed alarm and statistical criteria. The stored alpha and beta background counts for each detection channel count window are then subtracted from the corresponding measurement count windows to provide the contamination counts.

The monitor is designed to be automatic, quick, and easy to use, with no user controls and minimal user training. User

operating graphics and guidance are provided on a color LCD display and by spoken instructions in the chosen language. A five-color “traffic light” system gives operational status and instrument availability indications to users.

The monitoring sequences are initiated by hand, foot, and body sensors that guarantee the user adopts and maintains the correct monitoring position for the duration of the measurement. A color LED and count-down timer is displayed and audible “pips” give the user a positive indication of correct positioning, measurement progression, and time remaining.

Measurement results are presented on the color LCD. If all areas of the body are found to be below the user defined alarm level, a CLEAR message displays along with lighting the green status lamp and sounding traditional audible “chimes”. Contamination in excess of the alarm level is indicated on a pair of detector array mimics, one for each step, with alarming detectors colored red, accompanied by an ALARM message and audible dual-tone alarm “siren”. Numeric indication, in Alarm Level multiples, indicates contamination severity. A user programmable High Alarm action level may be automatically triggered in case of severe contamination, having an independent audible alarm to initiate external action.

A number of user-defined monitoring software features are available, including quick background update, interrupted measurement re-start mode, measurement quick-scan/early exit mode, and Radon compensation.

The iPCM12 is available in two basic physical styles. The “Open” “**A”** cabinet style (iPCM12**A**) allows free user entry and egress in any direction. The “Closed” cabinet style has a rear, portal-like structural cabinet extension that accommodates door/barrier system options (iPCM 12**B**), controlling user flow and lead shielding for the full body gamma option (iPCM12**C**).

The Gas-Flow Top-of-Head, Side-of-Foot, and Back-of-Shoulder detectors are available as stand alone options on all iPCM12 variants [2011 onwards]. A number of other options are available for all variants, including integral EPD and ID Bar-code readers, USB Camera kit, and calibration source jigs.

Closed (iPCM12C) versions accommodate gamma scintillation detectors and significant lead shielding. In addition to the Full-Body gamma kit, Top-of-Head, Side-of-Head, and gamma Hand kits are available as stand-alone options. Additionally, an Integral scintillation gamma Mini-SAM (Small Articles / Empty Pockets) Monitor will also be available in a future release.

The iPCM12 is provided with battery backup as standard, allowing continued operation in the event of a short-term (less

than 30 minute) power failure (optional powered doors are not battery backed).

Key Features

- Two step operation (open and closed versions) – see Positioning (page 5-97)
- Statistical alarming algorithm with several selectable parameters including Minimum Detectable Activity (MDA), confidence level, false alarm rate, and shielding factors – see Setup Menu (page 5-9)
- Large status indicator lights representing READY/CLEAR, RECOUNT, COUNT, ALARM, and OUT OF SERVICE as well as audible tones and voice instructions – see Five Light System (page 5-84)
- Identification of which detector alarmed (with lights) is displayed on the monitor – see Detector Indicator (page 5-84)
  Low level distributed contamination is also indicated.
- Battery backup for 30 minutes – see Battery/Mains Supply Indicator (page 5-115)

Nomenclature Codes

The build standard nomenclature is as follows:

iPCM12***u*** **-** ***l***

where: ***u*** is Unit Type (A, B, or C)
l is User language
i.e. – E English
– DE German
– C Chinese

Option Codes

The following Associated Equipment (AE) Option kits are available:

Gas Flow Quad-Detectors

- AE0223A*: Gas Flow (Fixed) Top-of-Head Detector Kit
- AE0221A: Gas Flow Side-of-Foot Detector Kit
- AE0251A***: Gas Flow Back-of-shoulder Kit (Future)
- AE0229A: Gas Flow Spare (Purged) Detector Kit
- AE0245A High Efficiency (Hex) Grille Kit

Plastic Scintillation Gamma Detectors (incl. heavy lead shielding)

- AE0222A*: Gamma Body, Head, Hand, and Foot Detector Kit
- AE0243A: Gamma Hand Detector Kit
- AE0224A*: Gamma Top-of-Head Detector Kit
- AE0248A**: Gamma Side-of-Head Detector Kit
- AE0253A: Gamma Integral Small Articleas Monitor (SAM) (Future)

* AE0223 and AE0224 (Top-of-Head Kits) are mutually exclusive.

** AE0248 mutually exclusive with standard GF (Side Head) Detector.

** AE0248 requires either AE0222A or 0224A kit to be fitted.

*** AE0251A mutually exclusive with AE0222A (full gamma kit)

Personnel ID Access and Data Recording

- AE0227A: USB Camera Kit
- AE0255A: EPD Reader (Basic UserID) (Future)
- AE0244A: USB Bar-Code Reader Kit

Personnel Flow Controls (PFCs)

Inlet PFC ***only*** is ***not*** a software-supported option.

Otherwise, the following Inlet, Exit, and Exit only PFC options are available, in any combination of Doors, Barriers, and Turnstiles:

- AE0239B: Manual Swing-Door Kit – Exit Only LH
- AE0240B: Manual Swing-Door Kit – Exit Only RH
- AE0238B: Manual Swing-Door Kit – Inlet and Exit Pair

- AE0239A: Powered Swing-Door Kit – Exit Only LH
- AE0240A: Powered Swing-Door Kit – Exit Only RH

- AE0238A: Powered Swing-Door Kit – Inlet and Exit Pair

- AE0237A: Powered Barrier Kit– Inlet or Exit

See Specification (page 3-1) for more information.

Chapter 2 Description

iPCM12 Cabinet Assemblies

iPCM12A

Basic Open Booth Cabinet Type 5715A

The basic iPCM12A cabinet, type 5715A, is an “Open” booth style of construction, allowing users open and free access from the front and sides. It is a sturdy sheet metal folded and welded fabrication with an industrial lightly textured powder-coat paint finish. It contains integral features and fixings to accommodate up to 24 large-area gas-flow detectors and electronics assemblies. The basic Open cabinet also has the mechanical infrastructure required to accommodate Gamma detector and shielding options and to attach the optional rear extension, which is required to form the Closed Booth models.

The instrument cabinet is built on a heavy-gauge, fabricated steel Base Plinth that accommodates two large-area gas flow detectors to independently monitor the soles of each foot. Facility is provided to secure the instrument to the floor (see Unpacking and Installation (page 4-1)). Two lifting channels are formed on the underside, to allow lifting and moving with both a low-profile Pallet-Jack truck and standard industrial forklift.

CAUTION: PLEASE REFER TO LIFTING & MOVING WARNINGS AND INSTRUCTIONS IN UNPACKING AND INSTALLATION (page 4-1) BEFORE MOVING IPCM12.

A “sculpted”, welded, fabricated steel body detector array frame accommodates twelve gas flow detectors in the center of the cubicle. The body detectors are arranged in a half-hexagon formation in the horizontal plane to accommodate the body torso. The body detector array is sculpted (angled) in the center in the vertical plane to accommodate body contours, particularly of rotund users. The body array frame is raised above the foot plinth, accommodating users’ feet beneath the frame to bring the front of their legs into close contact with the body detectors. The whole body detector array hinges open, allowing access to all body detectors for easy servicing. A hinged detector behind the body array makes close contact to monitor the tops of both feet/shoes. A User Guidance display comprising two colored lamps and a digital count-down status display is fitted on the left side of the array frame.

A fabricated, waist-high, vertical “island” assembly is located immediately to the right of the hinged body array frame. It accommodates three large-area gas flow detectors on the outer face to measure the side of the leg and the side of the foot/shoe. An additional detector located on the upper inner face provides coverage for the palm of the hand and the inner wrist and forearm.

A hinged, pivoting mechanism accommodates the outer hand detector. This mechanism, accessible from within the side service bay, ensures close contact monitoring of the back of the hand, wrist, and forearm.

A bulkhead fabrication, located to the right of the body arrays above the “island” assembly, accommodates up to three gas-flow detectors and the user color LCD/touch screen, USB ports, and optional EPD and bar-code ID scanners. The detectors, serviced from the side Service Bay, monitor the upperarm, shoulder, and side-of-head. The detector serviced from behind the main body array monitors the back of the shoulder.

A light-gauge steel roof plinth fabrication connects the body panels, bulkheads, and body array frame to provide structural rigidity and to accommodate a fixed geometry gas flow top-of-head detector. Fixing facilities are also provided for a speaker, two user traffic light clusters, AC mains power socket, Ethernet network connector, and a USB camera option.

A narrow door on the right side of the cabinet allows access to the Service Bay, which contains the main electronics, gas assemblies, and the outer hand, arm, and side-of-head gas flow detectors. The bulkhead on the right side of the Service Bay provides mounting facilities for up to five scintillation HV/Amplifiers for the gamma detector options. An optional “purged spare” gas flow detector can be accommodated on the inside of the service door.

The electronics and display assemblies are mounted within the Service Bay. The main Electronics Chassis is mounted on the upper left side of the Service Bay, immediately behind the color LCD and touch screen assembly. It comprises the Main Processor board, a DC-DC Converter PCB, a USB hub, User Accessories Panel, High Voltage Generator PCB, and optional General Purpose Input/Output (GPIO) (Door/Barrier) control PCB.

Below the Electronics Chassis is a separate Power Chassis, comprising an AC mains power supply, a Battery Controller PCB, and a 12-Volt Gel-cell mounted on the cabinet base plinth. An optional high capacity 12-Volt battery can be accommodated behind the right-hand bulkhead plate.

A Gas Chassis comprising gas control valves and a Gas Controller PCB is mounted above the Electronics Chassis.

iPCM12B and C

Closed Booth Cabinet Type 5719A

A cabinet extension is attached to the basic open cabinet (described above) to form the "Closed Booth Cabinet", type 5719A, utilized by the iPCM12 "**B**" and "**C**" variants. It is a sturdy sheet metal folded and welded fabrication with an industrial lightly textured powder-coat paint finish to match the basic open cabinet. It contains structural fixings to accommodate the lead shielding for gamma detector options and for the powered door and barrier options.

iPCM12 B

Closed Booth + Door and/or Barrier Kits

The iPCM12 "**B**" variant incorporates the optional cabinet extension, forming a "Closed" cubicle, to accommodate a variety of additional Personnel Flow Control (PFC) options. Simple powered swing barriers and full-height powered door options can be fitted in any combination, controlling user entry to, and egress from, the monitor – thus providing restricted and directional personnel flow control. See Option Codes (page 1-4) for range of PFC options.

iPCM12 C

Closed Booth + Full Body Gamma Kit

The iPCM12 "**C**" variant incorporates the optional cabinet extension, forming a "Closed" cubicle, and additionally the Full Body Gamma Option Kit, AE0222A. Plastic Scintillation detectors are located in the front of the cabinet behind the gas-flow body detectors, in the service door behind the hand mechanism, in the overhead location, and beneath the right gas-flow foot detector. All scintillation detectors are shielded on the back and all sides with 10 mm (~3/8") of lead shielding. The whole closed booth instrument sits on a base tray containing 20 mm (~3/4") of lead shielding. Additionally, the rear and left side walls of the closed cabinet extension are clad with 20 mm (~3/4") of lead shielding to produce a background shadow-shield wall.

WARNING: DUE TO THE SIGNIFICANT QUANTITY OF LEAD SHIELDING, THE iPCM12 C VARIANT WEIGHS ~ 1700 KG (~ 3,700 LBS). SPECIFIC ATTENTION SHOULD BE PAID TO FLOOR LOADING CONSIDERATIONS PRIOR TO INSTALLATION AND THE iPCM12 MUST NEVER BE MOVED WITH THE LEAD SHIELDING FITTED.

See the warnings in Unpacking and Installation (page 4-1) of this manual.

Electronics Chassis D92520/A

The Electronics Chassis is located on the upper left side of the Service Bay. It is a complete sub-assembly, mounted directly onto the iPCM12 cabinet and retained by ten hex pillars, facilitating easy removal for servicing. It comprises the Gas Chassis (Drg D92610/A), LCD Display assembly, Main Processor PCB (type 5712A), DC-DC Converter PCB (type 5714C), four port USB hub, User Accessories Panel, High Voltage Generator PCB (type 5713A) and optionally a GPIO PCB (type 5707A) – required to drive barrier and door options.

X-Channel Processor Board - Type 5712A

X-Channel Processor Board, type 5712A, is located near the top of the Electronics Chassis, mounted on the back of the color LCD/touch screen assembly. It is effectively a "motherboard", hosting a modular PC, decoding the PC signal sets, and implementing those functions that the iPCM12 X-Channel application requires. The plug-in PC module conforms to the international Embedded Technology Extended (ETX) standard. Therefore, any ETX-PC of suitable computing capacity may be fitted to overcome natural obsolescence, to implement advancing technology, or otherwise to enhance performance if increased application functionality is required.

Currently an ETX-PM(C) 1.5-GHz Celeron processor is used, with 512 Mb of RAM and a real time clock. An industrial grade 40-Gbyte hard disk is used to store Embedded Windows XP operating system, the application software, and iPCM monitoring data. Additionally, a 256-Mbyte Compact Flash backs up system calibration and configuration data.

In addition to the plug-in PC module, both the hard disk and the compact flash module are mounted on connectors, allowing quick on-site service replacement. The processor board is retained by six hex pillars and all system connections use easy release connectors, facilitating easy board removal and replacement, if necessary.

The 5712A motherboard interfaces directly to all other boards and external devices in the system:

- The application software is retrieved from a 40-Gbyte (minimum) hard disk drive via SK10. The drive also provides non-volatile storage for all data.
- PL15 provides a flash card storage medium for long term storage of important data
- 4 x USB port on SK4, 11, 15, 16. SK4 feeds the USB hub.

- Ethernet network interface SK201 (socket located on cabinet roof)
- VGA (CRT) monitor connection on SK3 (not used)
- LCD (XGA) drive on PL6 with backlight driver on PL7
- RS232 driver for LCD touch screen on PL2
- POWER input connector PL10 (Five-Way)
- Loudspeaker connection for sound generator on PL1
- I^2C bus comms for Five-Way LED cluster displays on PL9
- RS-422 X-Channel Comms interface on SK1, 6, 7, 8, 13 and 14
- I^2C bus comms for 5711A User Guidance Display on PL9

LCD Display and Touch Screen Assembly

The Color LCD Display and Touch screen Assembly is mounted on the Electronics Chassis, located immediately in front of the 5712A Processor board. The Display assembly (D92583/A), used in portrait orientation, comprises a number of proprietary parts: NEC color TFT 1024 X 768 (XGA) resolution, dual-CCFL backlit LCD display, dual-output Backlight Inverter, high voltage generator module, resistive five-wire laminated touch screen, and RS232 touch screen controller PCB, type SC4.

WARNING: THE BACKLIGHT INVERTER MODULE GENERATES HAZARDOUS-LIVE HIGH VOLTAGES. REFER TO THE WARNINGS IN MAINTENANCE AND TROUBLE SHOOTING (PAGE 11-1).

THE BACKLIGHT INVERTER IS A PROPRIETARY MODULE AND IS NOT USER SERVICEABLE.

DC-DC Converter Board Type 5714C

A DC-DC Converter board, type 5714C, is mounted on the Electronics Chassis, immediately below the 5712A Processor board. It is retained by four hex pillars, facilitating easy removal and replacement. The 5714C board produces stabilized low-voltage output supplies from the primary system DC supply. It has a wide primary input range of +9 V to +18 V DC, allowing the iPCM system to run from either the normal AC mains PSU +18 Volt DC output or otherwise from the (discharging) +12 Volt battery output, in the event of AC mains power failure. Three proprietary DC-DC converter modules produce stabilized +5 Volt, +12 Volt, and -12 Volt outputs. Low voltage power is supplied to the 5712A Processor board

and the USB hub. Power is also available at auxiliary sockets to supply additional options, for example, EPD and Bar-Code readers.

User Accessories Panel

The User Accessories Panel is mounted on the Electronics Chassis, located immediately below the 5714C DC-DC Converter board. It is supplied as a standard blank plate with a Thermo label on the front. It is intended to accommodate user defined options, including Electronic Dosimeter (EPD) readers and Bar-code/ID badge scanners. The standard blanking panel is replaced by a suitably customized and labelled panel that physically accommodates the mechanical and electronic hardware of the required option. Power is available via auxiliary connectors on the immediately adjacent 5714C DC-DC Converter board. Custom software will be required, depending upon the application.

Universal USB Hub

A proprietary four-port USB Hub is mounted on the Electronics Chassis, located immediately below the User Accessories Panel. The primary USB feed is via SK4 on the 5712**A** Processor board. The four USB sockets are accessed from inside the iPCM12 booth, allowing keyboard, mouse, security dongle, memory sticks, and other USB devices to be used in conjunction with the LCD display. The sockets are fitted with protective rubber plugs to prevent accidental contact and are also short-circuit protected.

X-Channel HV Generator PCB Type 5713A

A High Voltage Generator board, type 5713A, is mounted at the bottom of the Electronics Chassis, located immediately below and to the right of the USB Hub. It is retained by six hex pillars and protected by a metal screen.

The PCB generates a single High Voltage supply specifically for use with gas flow detectors, typically around 1700 Volts DC for argon/methane gas mixtures, but is capable of generating in excess of 3500 Volts DC for other applications and gas mixtures.

The single high voltage output is supplied at two insulated front panel connectors, each having series current limiting impedances required to limit the stored charge in each “arm” of the HV circuits. A red “HV Enabled” LED indicates the status of the HV generator – the HV is being demanded when the “enabled” LED is lit. The HV output is current limited and short-circuit protected.

The PCB has two green LEDs that show FPGA and Software status plus two X-Channel LEDs, amber and green, that show network communication status.

LED	Color	Purpose
D15	Red	Attention Indicator – used during X-Channel setup.
D17	Green	Firmware Good – Flashing indicates software is running but configuration data is invalid
D16	Green	FPGA Good
D14	Yellow	X-Channel Receive Data
D13	Green	X-Channel Transmit Data
D5	Red	HV On

WARNING: THE 5713A HIGH VOLTAGE GENERATOR PRODUCES DANGEROUS HIGH VOLTAGES AND HAZARDOUS-LIVE VOLTAGES EXIST WITHIN THE METAL SCREEN. REFER TO THE WARNINGS IN MAINTENANCE AND TROUBLE SHOOTING (PAGE 11-1). DO NOT REMOVE THE METAL SCREEN IF THE RED HVENABLED LED IS LIT AND FOR TWO MINUTES AFTER THE LED IS EXTINGUISHED.

X-Channel GPIO Board Type 5707A

NOTE: Optional - used in conjunction with AE Door and Barrier Kits

An optional GPIO board, type 5707A, is mounted at the bottom of the Electronics Chassis, located immediately to the left of the HV Generator. It is retained by six hex pillars for easy servicing. Two green LEDs show FPGA and Software status and two X-Channel LEDs, amber and green, show network communication status.

LED	Color	Purpose
D8	Red	Attention Indicator – used during X-Channel setup
D9	Green	Firmware Good – Flashing indicates software is running but configuration data is invalid
D10	Green	FPGA Good
D4	Yellow	X-Channel Receive Data
D5	Green	X-Channel Transmit Data

A single GPIO board provides the necessary power drives and monitoring circuitry required to control any combination of inlet and exit powered doors and barriers.

Additional wiring specific to the Doors and Barrier option kits is also required.

Power Chassis D92520/A

The Power Chassis is located on the lower left side of the Service Bay, immediately below the Electronics Chassis. It is a complete sub-assembly, mounted directly onto the iPCM12 cabinet and retained by six hex pillars, facilitating easy removal for servicing.

The AC power input to the Power Chassis ON/OFF switch is via a screened cable from an IEC connector mounted on the top roof plinth.

The Power Chassis comprises a proprietary AC mains switched-mode power supply, a mains ON/OFF switch and a Battery Controller board, type 5720A (when fitted; currently type 5703A). A 12-Volt Gel-cell battery is mounted on the cabinet floor, immediately below the power chassis. Optionally, a high capacity 12-Volt battery is mounted behind the right-hand bulkhead plate.

AC Mains Power Supply

The AC Mains Power Supply is a proprietary switch-mode unit, located at the bottom of the power chassis. It has a wide auto-ranging (110 V – 240 V) AC input and produces a single +18 Volt DC output at 8 Amps (150 Watts). The PSU is located on a mounting plate for easy service exchange, and is fitted with a proprietary safety cover. The AC mains terminals are shrouded by a metal cover, which also incorporates the AC mains ON/OFF power switch.

A green LED, visible through the case, indicates that AC voltage is present and DC output voltage is being generated. The DC output is internally fused.

WARNING: THIS AC MAINS POWER SUPPLY CONTAINS DANGEROUS AC MAINS AND HIGH DC SWITCHING VOLTAGE WITHIN THE SCREENING COVERS. REFER TO THE WARNINGS IN MAINTENANCE AND TROUBLE SHOOTING (PAGE 11-1). DO NOT REMOVE THE METAL SCREENS WITH THE AC VOLTAGE APPLIED. THIS IS A PROPRIETARY UNIT AND IS NOT USER SERVICEABLE.

Battery Controller PCB Type 5703A

The Battery Controller Board, type 5703A, manages the charging of a 12- volt sealed lead-acid battery. The 5703A Battery Controller operates on the early X-Channel-1 bus and is fitted to early iPCM12 **A** (Open) units only. It manages charging of the smaller 17 A/hr battery only. The 5703A will be superseded by the enhanced (heavy duty) 5720A on all later iPCM12 variants.

The whole electronics system is powered from the 5703A board, which constantly senses the charge/discharge state of the battery and controls the charging voltage accordingly. The charging voltage is temperature compensated by means of a thermistor located on the battery, helping to maximize the life time of the battery.

Momentary operation of the front panel key-switch into the START position allows power to be switched to the electronics. This function operates in the absence of AC mains power provided the battery charge (voltage) status is sufficient (i.e., battery is not discharged). The key-switch needs to be held ON for at least two seconds before the ON state is engaged.

The 5703A continues to monitor the terminal voltage of the battery during battery operation and will signal a shut-down if the battery discharges to a predetermined point, beyond which it would suffer permanent (deep discharge) damage and be difficult to recharge. A miniature on-board fuse protects against over-current conditions.

The application software would normally regulate shut-down. In the event of the software losing control, an emergency shut-down is possible by holding the key-switch ON for a minimum of 10 seconds (nominal).

X-Channel Battery Controller PCB Type 5720A

When available, Battery Controller Board, type 5720A will manage the charging of Heavy Duty 12-volt sealed lead-acid batteries, up to a maximum capacity of 38 A/hr. The 5720A supersedes the original 5703A Battery Controller used in early iPCM12 **A** (Open) units. The 5720A operates on the later X-Channel-2 bus, used on all other IPCM12 Gas Flow instrument boards.

Functionally, the 5720A replicates the early 5703A and will also have several enhanced functions.

Gas Chassis D92610/A

The Gas Chassis is mounted at the top of the Electronics Chassis, immediately above the Processor and LCD assembly, and retained by six hex pillers for easy removal. It is comprised of a Gas Flow Sensor board, type 5709A, gas filter, solenoids, and manual flow control valves. A pressure relief valve, located on the gas inlet line, vents the gas in the event of over-pressure to avoid detector window damage. The gas escaping through the valve is included in the inlet flow but not in the outlet flow. The Gas Chassis also contains bulkhead connectors for gas supply and exhaust piping.

X-Channel Gas Flow Sensor Board Type 5709A

Gas Flow Sensor Board, type 5709A is located at the top of the Electronics Chassis, mounted horizontally on the Gas Chassis and retained by four hex pillars for easy service replacement.

The 5709A interfaces with the X-Channel-2 network protocol. It has two green LEDs that show FPGA and Software status plus two X-Channel LEDs, amber and green, that show network communication status.

LED	Color	Purpose
D8	Red	Attention Indicator – used during X-Channel setup
D9	Green	Firmware Good – Flashing indicates software is running but configuration data is invalid
D10	Green	FPGA Good
D4	Yellow	X-Channel Receive Data
D5	Green	X-Channel Transmit Data

The 5709A controls switching of the “Purge” and “Normal” flow solenoid valves, under application software control, to direct the required level of gas flow through the iPCM12 detectors. It also interfaces directly to the electronic gas flow sensors, monitoring the Inlet and Exhaust flow rates, enabling automatic detection of leaks and low and high flows before iPCM12 efficiency function is degraded or physical damage occurs.

Display Assemblies

All system variants have a User Guidance Display, type 5711A, and either one or two Five-Way LED Cluster ("Traffic Light") Display boards, type 5672A.

User Guidance Display Board Type 5711A

The User Guidance Display, type 5711A, is located in the left side upright of the hinged body detector array frame, approximately at eye level. It is driven from the I^2C bus and is comprised of two colored LED lamps and a two-digit numerical timer display.

The two LED lamp clusters are user positioning aids: the Amber "*Position Body Facing Detectors*" LED on the first, forward measurement, and the white "*Position Back to Detectors*" LED on the second, backward measurement. These LED clusters extinguish when the correct position is adopted. The two-digit "*Time Remaining*" display is used during both measurement cycles to show the user the monitoring count has started and the count time remaining.

Five-Way LED Cluster Board Type 5672A

The Five-Way LED Cluster ("Traffic Light") Display boards, type 5672A, are driven from the I^2C bus and mounted in the cabinet roof plinth. iPCM12 **A** (Open cabinet) variants have a single LED cluster mounted in the cabinet roof front face, and optionally a second cluster mounted in the left or right side of the roof. iPCM12 **B** and **C** (Closed cabinet) variants, with or without doors, have two LED clusters, one mounted in each side of the cabinet roof – or in the mechanism header assemblies if doors are fitted. Only two LED clusters can be driven from the I^2C bus due to power limitations.

The LED "Traffic Light" clusters are used to inform users of iPCM12 system status, monitoring availability and, where doors are fitted, control user flows. The five color indications are:

Green	Clear / Ready
White	Recount
Amber	Count
Red	Alarm
Blue	Out of Service

Gas Flow Alpha/Beta Detectors

All iPCM12 variants are fitted with twenty-one Gas Flow Alpha/Beta detectors as standard. Optionally, three additional (Side-of-Foot, Top-of-Head and Purged Spare) detectors can be fitted to suit user requirements.

Quad Gas Flow α/β Detector Type 5710A

The Quad Detector, type 5710A, is a large area alpha- and beta-sensitive gas flow detector. This single size of detector, carefully chosen to suit optimum measurement geometry, is used to monitor all parts of the body. The single detector size allows an optional on-board purged spare to service any detector in the system and reduces spares inventory. Detectors are retained with Velcro straps and all gas and electrical connections are manual, so detector changing requires no tools. A simple "O" ring seal and disposable, pre-foiled window carrier makes replacement of damaged windows quick, easy, and reliably gas-tight.

The detector body is machined from an aluminium extrusion and the window support plate is laser-cut and secured with screws. Detector windows are protected by a separate rugged square-mesh grille, or optionally by a high-transmission hex grille.

The large (712 cm^2) detector active area is internally sub-divided into effectively four separate detectors – quad channel – each 178 cm^2. The separate anode wire of each detection channel is connected to the input of a charge-sensitive Quad Amplifier, type 5704A, mounted directly on the back of the detector body. A centrally generated high voltage, distributed to each detector anode, and a low-pressure, low-flow Argon/Methane gas mixture are used to produce ionization charge amplification.

Up to 24 Quad detectors can be fitted, creating up to 96 individual counting zones and therefore generating 192 measurements (alpha and beta) for the whole body.

WARNING: THE 5710A DETECTOR CONTAINS HIGH VOLTAGES INTERNALLY ON THE ANODE WIRES AND ALSO WITHIN THE COVER ON THE 5704A AMPLIFIER. REFER TO THE WARNINGS IN MAINTENANCE AND TROUBLE SHOOTING (PAGE 11-1). DO NOT REMOVE THE METAL SCREEN IF THE HV IS ENABLED AND FOR TWO MINUTES AFTER THE HV IS REMOVED.

X-Channel Quad Charge Amplifier Type 5704A

The Quad Amplifier, Type 5704A, is mounted directly to the back of the 5710A Quad Detector body and fitted with a metal screening cover. It has four identical charge sensitive amplifiers, each one connected to a separate anode wire within the 5710A Quad Detector body. Centrally generated and distributed high voltage is received via an HV connector and routed to each anode wire via the Quad Amplifier PCB. Charge pulses received from the detector are amplified, fed through alpha/beta descriminators, counted, and stored on-board for subsequent X-Channel transmission to the host ETX processor. Each detection channel has two beta energy windows, two alpha energy windows, and a Radon channel. An I/O port on each Quad Amplifier PCB has the capability to control and read the status of body photobeam position sensors. Where this is utilized, sensor status data is transmitted back to the host processor via the X-Channel network, thus simplifying the system wiring.

It has two green LEDs that show FPGA and Software status plus two X-Channel LEDs, amber and green, that show network communication status.

LED	Color	Purpose
D15	Red	Attention Indicator – used during X-Channel setup
D17	Green	Firmware Good – Flashing indicates software is running but configuration data is invalid
D16	Green	FPGA Good
D14	Yellow	X-Channel Receive Data
D13	Green	X-Channel Transmit Data

WARNING: THE 5704A QUAD AMPLIFIER CONTAINS HIGH VOLTAGES WITHIN THE SCREENING COVER. REFER TO THE WARNINGS IN MAINTENANCE AND TROUBLE SHOOTING (PAGE 11-1). DO NOT REMOVE THE METAL SCREEN IF THE HV IS ENABLED. FIT AN HV SHORTING LINK (PROVIDED WITH THE SPARE DETECTOR) TO THE HV CONNECTOR PRIOR TO HANDLING OR REPLACING THE DETECTOR, OR REMOVING THE METAL SCREENING COVER. BE AWARE THAT DIELECTRIC RECOVERY CAN RE-GENERATE SIGNIFICANT STORED CHARGE – LEAVE THE HV SHORTING LINK IN PLACE DURING SERVICING.

Scintillation Gamma Detectors

Optionally, all iPCM12 variants can be fitted with various Scintillation Gamma Detectors. The Hand, Top-of-Head, and Side-of-Head Scintillation AE kits can be fitted to all variants, including the “A” (Open) version. The Full Body Gamma Kit (AE0222A) can be fitted to Closed versions (iPCM 12 “B”) The iPCM12 “C” variant includes the gamma kit.

Scintillation Gamma Detectors Type 5708A and 5717A

Scintillation Gamma Detectors, Types 5708A and 5717A, are large area solid blocks of plastic scintillator, with an integral Photomultiplier Tube (PMT) embedded in an oil filled cavity. Each detector is wrapped in reflective foil and a light-tight plastic jacket. These detectors can either be specified as separate Associated Equipment (AE) options if required individually, or are supplied as part of the Full Body Gamma Kit fitted to iPCM12 “C” variant (AE0222A).

The smaller 5708A detector is used to detect gamma contamination on the hand, foot, top of head, and side of head. Each detector is individually shielded with 10 mm of lead on the rear face and all four sides.

Six large body detectors, type 5717A, are large area plastic rhomboid- shaped scintillators wrapped in foil and plastic. Additionally, three rectangular scintillation detectors, type 5708A, are used for hand, foot, and head monitoring.

Connection to the dynode chain assembly is via a light-tight gland mounted on the back of the tube. A single coaxial cable provides high voltage for the tube and carries the signals to the HV and Amplifier PCB via an MHV connector. For further information, see Detectors (page 5-27) of this manual.

Scintillation HV and Amplifier Type 42543-0223 (FHT681)

NOTE: Used in iPCM12C variants

The Scintillation HV and Amplifier Board, type FHT681, is a dual-channel high voltage generator/scintillation amplifier operating on the X-Channel-1 bus protocol. The HV generators are sub-assemblies (type 42543-0202) which are controlled by DACs (Digital to Analogue Converter) on the main PCB. The HV generator has a range of between 0 and 1400 Volts, with a resolution of approximately 1 Volt.

The charge pulses arriving along the high voltage cable from the scintillation detectors are amplified; each is fed to five

discriminators and five associated counters, all controlled by the microprocessor on the main board. The cards are interrogated via the X-Channel bus to retrieve counter values generated every 100 ms from a five second buffer.

Chapter 3 Specification

Cabinet Styles

The Installed Personnel Contamination Monitor, type iPCM12, is available in two basic mechanical cabinet styles, ***Open*** and ***Closed*****:**

- Unit Type / Style:
  - iPCM12 **A** Open Cabinet Style (Basic Instrument)
  - iPCM12 **B** Closed Cabinet Style + PFC* options
  - iPCM12 **C** Closed Cabinet Style + Gamma options

Detector Types

Three types of detector technologies are also available:

- Detector Types:
  - Gas Flow: All Variants – Ar/CH_4 and Ar/CO_2 Gas Mixtures
  - Gas Sealed: All Variants - (Future Option)
  - Scintillation: Gamma Options (Variant Restrictions)

Language Options

An (expanding) number of language translations are optionally available. The major *User* messages, displayed and spoken, can be translated into local languages, as required, for example:

- Languages:
  - E: English
  - DE: German
  - C: Chinese

See standard Nomenclature Codes in the Introduction (page 1-1).

Additionally, a number of AE Option Kits are available for the iPCM12. They provide additional Gas Flow detectors and ancillary equipment to the standard alpha/beta units, and also a range of Scintillation detectors for simultaneous gamma monitoring. Many options are suitable for both cabinet styles, but some are restricted to Closed (B and C) Variants only. See options table below:

Option Kits

Option Kit	Option Description:	Open A	Closed B and C
AE 0221A	GF Side-of-Foot Detector	✓	✓
AE 0223A**	GF Top-of-Head Detector	✓	✓
AE 0251A****	GF Back-of-Shoulder Detector	✓	✓
AE 0229A	GF Spare (purged) Detector	✓	✓
AE 0245A	GF High Efficiency (Hex) grille	✓	✓
AE 0222A	Gamma Full Body Detector Kit	x	✓
AE 0243A	Gamma Hand Detector Kit	✓	✓
AE 0224A**	Gamma Top-of-Head Kit	✓	✓
AE 0248A***	Gamma Side-of-Head Kit	✓	✓
AE 0253A	Gamma Integral Mini SAM	x	✓
AE 0227A	USB Camera Kit	✓	✓
AE 0255A	EPD Reader Kit (Basic User ID)	✓	✓
AE 0244A	USB Bar-Code Reader Kit	✓	✓
AE 02XXA	Heavy Duty Power System	✓	✓
			✓
AE 0239A	Powered Door – Exit Only L/H	x	✓
AE 0240A	Powered Door – Exit Only R/H	x	✓
AE 0238A	Powered Door – Inlet and Exit Pair	x	✓
AE 0237A	Powered Barrier – Inlet and Exit	x	✓
AE 0239B	Manual Door – Exit Only L/H	x	✓
AE 0240B	Manual Door – Exit Only R/H	x	✓
AE 0238B	Manual Door – Inlet and Exit Pair	x	✓

* Personnel Flow Controls (PFC) = Doors/Barriers/Turnstiles

** AE0223 and AE0224 (Top-of-Head) Kits are mutually exclusive.

*** AE0248 is mutually exclusive with standard GF Side-of Head Detector

*** AE0248 requires either AE 0222 or AE 0224 Kit to be fitted.

**** AE0251A is mutually exclusive with the AE0222A Gamma full body detector kit.

Operational Parameters

See Setup Menu|Monitoring (page 5-14) for information regarding the settings and defaults for the Operational Parameters.

Software Options

See Setup Menu|UI Options (page 5-9) and Setup Menu|Operation (page 5-11) for information regarding the settings and defaults for the Software Options.

Default Messages

See Setup Menu|Messages (page 5-25) for information regarding the settings and defaults for the Software Options.

Background Capability

Background capability is related to alarm threshold and statistical certainty requirements. Alpha and Beta/Gamma background subtraction is included in the Monitor's measuring routines.

When any of the Operational Parameters are changed, the monitoring time required will be automatically reassessed in relation to the measurement certainty required and the prevailing background conditions. Since the gas flow detectors have a high gamma rejection, the operational background limit will be dictated by the scintillation detector count rates and proportional to the amount of shielding employed where the gamma monitoring option is fitted.

An "Out of Service – High Background" indication is given if backgrounds exceed levels required for correct operation. Under these conditions, the background must either be reduced to an acceptable level or the alarm levels and/or measurement certainties required must be relaxed, and/or the (maximum) monitoring time must be increased.

A Background Attenuation Compensation Factor facility is provided. This factor compensates for the attenuation and/or scattering of background radiation caused by a user when in the monitoring position.

For Alpha and Beta Backgrounds, monitoring will be based over a 100 to 300 second count in 10 second segments, which is maintained on a "rolling average" basis. For Gamma

Backgrounds, monitoring will be based over one second check periods; each one second period will contribute to a rolling average of up to 300 periods.

An optional “Quick Start” software function allows monitoring to commence more quickly after a minimum of 20 seconds, provided background stability criteria are met, by using an increased monitoring time to meet the statistical and alarm level requirements.

A significant change in the measured background count rate from the mean will cause the iPCM12 to discard the current mean value and restart background monitoring (see UserMode|Changing Background (page 6-14)).

If, due to continuous operation, the iPCM12 has been unable to measure background for 15 minutes, a 10 second background count is performed immediately after the current monitoring sequence. If no significant change is detected, the machine will be available for further monitoring. If a change in background is detected, further background measurements are performed until the iPCM12 detects a stable background (see UserMode|Changes to the Normal Background Monitoring (page 5-92)).

When the mandatory full background count has been accumulated, the monitoring time required to achieve the specified alarm level is calculated. Providing the monitoring time calculated falls within the maximum and minimum limits (see Monitoring (page 5-14)), the instrument will be ready for monitoring. If, however, the monitoring time calculated is greater than the maximum allowed, a "high background" condition exists and monitoring will be inhibited.

A high background condition indicates that the alarm level set and statistical certainties required are not achievable under the current background conditions. This condition will auto-recover when the background falls or otherwise more suitable (relaxed) operational parameters are entered by the Health Physicist. It is advisable to check for residual contamination if this occurs unexpectedly or persists.

The lower and more stable the background field, the more sensitive, stable, and accurate user measurements will be.

A Background Attenuation compensation factor facility is provided. This factor compensates for the attenuation and/or scatter of background radiation caused by an operator when in the monitoring position.

Gas Flow Detectors

All iPCM12 A, B, and C variants are fitted with alpha- and beta-sensitive large area Gas Flow Detectors, as standard. All detectors are internally sub-divided into four individual (Quad) detection channels and protected by a separate, external, protective grille.

Additionally, a number of Scintillation detector AE Option Kits can be fitted to give the iPCM12 gamma detection capability.

Gas Flow Quad Detector Type 5710A

A single-size Gas Flow Quad Detector, type 5710A, is used to monitor all parts of the body. A Quad Amplifier, type 5704A, is mounted directly on the back of the detector body. Common features of the 5710A Quad Gas Flow Detector are:

Overall External Body Dims:	468 x 181 x ~50 mm (inc.Window and Amp)
Total Active Area:	445 x 160 mm (712cm²)
Quadrant Active Area:	111 x 160 mm (178cm²)
Mylar Window Foil Density:	0.9 mg/cm^2 - aluminized both sides.
Mylar Window Foil Thickness:	6 microns (0.006 mm).
Standard "Rugged" Square Grille:	1 mm thick ~ 50% Transmission
Standard Hex Foot Tread Plate:	3 mm thick ~ 70% Transmission.
Optional "High Eff" Hex Grille:	1 mm thick ~ 70% Transmission
Gamma Response - Per Detection Quadrant Active Area:	approx. 55 cps in a uniform field of 1μSv/h due to 662 keV photons

Operating Voltage: (at Sea Level)	1,650 V for 5% Methane in Argon (P5)
	1,700 V for 7.5% Methane in Argon (P7½) - recommended*
	1,750 V for 10% Methane in Argon (P10)
	1800 V for 10% CO_2 in Argon
	1850 V for 20% CO_2 in Argon
Window Material:	Single Mylar sheet aluminized both sides
	Standard weight is 0.9 mg/cm^2

Body, Hand, Head Detector 5710A (19-22 per iPCM12)

Typical performance to sources with 100 cm^2 of traceable Surface Emission Rate (SER) placed in contact with the protective Grille.

Smaller sources will yield higher efficiencies.

Standard Rugged Grille (~50% Transmission)

Alpha Efficiency: (% of SER)	Americium-241	28%
Beta Efficiency: (% of SER)	Carbon-14	22%
	Cobalt-60	31%
	Chlorine-36	37%
	Strontium/Yttrium-90	39%

High Efficiency Grille (~ 70% Transmission)

Alpha Efficiency: (% of SER)	Americium-241	40%
Beta Efficiency: (% of SER)	Carbon-14	30%
	Chlorine-36	50%

Foot Detector Type 5710A (2 per iPCM12)

Typical performance to sources with 100 cm^2 of traceable surface emission rate placed on Foot Plinth Tread Plate. Window Support frame in contact with stainless steel foot grille.

Smaller sources will yield higher efficiencies.

Standard Hex Tread Plate (~70% Transmission)

Alpha Efficiency: (% of SER)	Americium-241	32%
Beta Efficiency: (% of SER)	Carbon-14	25%
	Cobalt-60	35%
	Chlorine-36	43%
	Strontium/Yttrium-90	43%

NOTES:

- All gas flow efficiencies are Typical for P7½ gas @ 1,700 V @ sea level.
- Efficiency variations up to ±10% are possible for beta contaminants
- Efficiency variations up to ±15% are possible for alphas where manufacturing tolerances are more critical.
- Please read note in Gas Flow Quad Detectors - Removal and Replacement (page 11-17).

- Depth dimensions include head amplifier and fixing screws.
- Working voltages may be reduced by 200 V at 8,000 feet above sea level.

Scintillation Detector (Options)

All iPCM12 A, B, and C variants can be fitted with a range of Scintillation Detector Gamma options. Some however, due to the lead shielding required, are restricted to the Closed (B and C) cabinet styles. See table in Option Kits on page 3-2.

Scintillator Construction

All Scintillation Detectors used in iPCM12 Option Kits utilize Embedded Photomultiplier technology, to maximize coverage and minimize "dead" areas. Common sizes are used where possible to minimize spares inventory. Common construction specification:

Plastic:	NE110 or equivalent
Thickness:	57 mm (2.25 inches)
Photomultiplier:	Type B9900-B07 25 mm (1 inch) Extended Photo-cathode
Construction:	Embedded PMT and Dynode. Foil wrapped with light-tight plastic jacket.
Shielding:	10 mm Low-Background lead on external face and sides.
Energy Response:	20 keV – 2 Mev photons.

Hand, Foot, & Head Scintillator

Type No.:	5708A
Construction:	As detailed above
Profile:	Rectangular (Universal Use)
Overall Size:	520 mm long x 160 mm wide x 57 mm thick
Detection Area:	832 cm^2 (129 in^2)
Detection Vol:	4,742 cm^3 (290 in^3)

Body Scintillator

Type No.:	5717A
Construction:	As detailed above
Profile:	Rhomboid (Left and Right Body Reversible)
Overall Size:	520 mm long x 325 mm at widest x 57 mm thick
Detection Area:	1690 cm^2 (262 in^2) larger face
Detection Vol:	9,632 cm^3 (589 in^3)

Side of Head Scintillator

Type No.:	5724A
Construction:	As detailed above
Profile:	Rectangular (Universal Use)
Overall Size:	430 mm long x 158 mm wide x 57 mm thick
Detection Area:	679 cm^2 (105 in^2)
Detection Vol:	3873 cm^3 (236 in^3)

Mini SAM Scintillator

Type No.:	5724A
Construction:	As detailed above.
Profile:	Rectangular (Universal Use)
Overall Size:	430 mm long x 158 mm wide x 57 mm thick
Detection Area:	679 cm^2 (105 in^2)
Detection Vol:	3873 cm^3 (236 in^3)

Alpha and Beta Detection Efficiencies

Detection Efficiencies have been determined in accordance with the procedures defined by International Electrotechnical Commission Standard for Installed Personnel Warning Assemblies, **IEC 61098**.

Hand & Foot Alpha / Beta Contact Efficiency (Typical SER/2π)

Alpha and Beta Hand detection efficiencies are measured with sources placed inside the hand mechanism, in contact with the protective grilles.

Foot detection efficiencies are measured with sources placed directly in contact with the standard (High Efficiency) hex tread plate.

The sources used to derive these efficiencies have an area of 100 or 150 cm^2. Smaller area sources will yield larger efficiencies.

Source	Detector	Energy	Type	2π Efficiency	
				Rugged Grille	Hi Eff Grille
^{55}Fe	Hand	5.9 keV	X-ray	20 %	
^{55}Fe	Foot	5.9 keV	X-ray	27 %	
^{63}Ni	Hand	67 keV	Beta	5.0 %	
^{63}Ni	Foot	67 keV	Beta	3.6 %	
^{14}C	Hand	156 keV	Beta	22 %	31 %
^{14}C	Foot	156 keV	Beta	25 %	
^{36}Cl	Hand	709 keV	Beta	37 %	50 %
^{36}Cl	Foot	709 keV	Beta	43 %	
^{60}Co	Hand	318 keV	Beta	31 %	41 %

Source	Detector	Energy	Type	2π Efficiency	
				Rugged Grille	Hi Eff Grille
^{60}Co	Foot	318 keV	Beta	35 %	
^{137}Cs	Hand	514 keV	Beta	40 %	53 %
^{137}Cs	Foot	514 keV	Beta	48 %	
^{90}Sr/^{90}Y	Hand	2280 keV	Beta	40 %	50 %
^{90}Sr/^{90}Y	Foot	2280 keV	Beta	43 %	
^{241}Am	Hand	5.5 MeV	Alpha	28 %	40 %
^{241}Am	Foot	5.5 MeV	Alpha	32 %	
^{238}U	Hand	4.2 MeV	Alpha	23 %	30 %
^{238}U	Foot	4.2 MeV	Alpha	21 %	

Alpha / Beta Body Average Efficiency (Typical 4π)

In accordance with IEC 61098, body detection efficiencies are measured and quoted as “Body Average Efficiency” @ 50 mm from the detector window, which accounts for body contours and is more meaningful than contact efficiencies:

Source	Energy	Type	Grilles	Un-Summed	Summed Double Detectors
^{14}C	156 keV	Beta	Std/Rugged	0.9 %	1.0 %
^{36}Cl	709 keV	Beta	Std/Rugged	6.7 %	7.6 %
^{60}Co	318 keV	Beta	Std/Rugged	3.6 %	4.1 %

Gamma Detection Efficiencies

Detection Efficiencies have been determined in accordance with the procedures defined by International Electrotechnical Commission Standard for Installed Personnel Warning Assemblies, **IEC 61098**.

Hand & Foot Gamma Efficiency (Typical Activity / 4π)

Gamma Hand efficiencies are measured with sources placed inside the hand mechanism, in contact with the protective grilles:

Foot efficiencies are measured with sources placed in contact with the Right foot (high efficiency) hex treadplate:

Source	Detector	Energy	Type	4π Efficiency
^{57}Co	Hand	122 keV	Gamma	1.9 %
^{57}Co	Foot	122 keV	Gamma	3.7 %
^{137}Cs	Hand	662 keV	Gamma	3.4 %
^{137}Cs	Foot	662 keV	Gamma	8.4 %
^{60}Co	Hand	1250 keV	Gamma	7.7 %
^{60}Co	Foot	1250 keV	Gamma	15.8 %
^{60}Co Win*	Hand	1250 keV	Gamma	2.7 %
^{60}Co Win*	Foot	1250 keV	Gamma	6.7 %

* ^{60}Co Win refers to efficiency of the '^{60}Co Window' to ^{60}Co.

Gamma Body Average Efficiency (Typical 4π)

In accordance with IEC 61098, gamma body detection efficiencies are measured and quoted as "Body Average Efficiency" @ 50 mm gas flow detector windows:

Source	Energy	Type	Grille	Un-Summed	Summed Triple Detectors
^{57}Co	122 keV	Gamma	Std/Rugged	2.3 %	3.4 %
^{137}Cs	662 keV	Gamma	Std/Rugged	4.9 %	8.0 %
^{60}Co	1250 keV	Gamma	Std/Rugged	10.0 %	15.8 %
^{60}Co Win*	1250 keV	Gamma	Std/Rugged	3.6 %	5.6 %

* ^{60}Co Win refers to efficiency of the '^{60}Co Window' to ^{60}Co.

Mini SAM Efficiency (Typical 4π)

Integral Mini SAM efficiencies, in accordance with standard SAM calibration procedures, are measured in contact with the liner base, and also at 75 mm (3 inches) above the liner floor (approximately the center of the sensitive volume).

Source	Energy	Type	Liner Base	Center Volume
^{57}Co	122 keV	Gamma	TBD %	TBD %
^{137}Cs	662 keV	Gamma	TBD %	TBD %
^{60}Co	1250 keV	Gamma	TBD %	TBD %

Processing and Communications

The iPCM12A has a Central Processing unit, based on the ETX standard, communicating with a range of remote, intelligent peripheral boards over an X-Channel network.

The ETX processor currently in use can be substituted for any other ETX processor of suitable processing power in the event of obsolescence or to enhance system functionality.

Central Processor

Form Factor:	ETX
Family:	Intel Celeron M
Speed:	1.5 GHz
Memory:	512 Mbyte SDRAM
Hard Disk:	SerialATA x2, ParallelATA x2
USB:	4 x USB 2.0
Ethernet:	10/100 Mbit
Sound:	AC97
Video Contr.	Integrated Intel 82855GME
LVDS:	Resolution up to 1600 x 1200 (UXGA)
LVDS – LCD:	Single and Dual Channel LVDS (2x18/24 bit)
Com Ports:	COM 1+2 (TTL)
Power Supply:	+5 Volts DC
Power:	10W Idle Typical
Temperature:	0ºC to +60 ºC

Motherboard

Type:	5712A
Plug-In PC:	ETX Celeron-M
Hard Disk:	40 Gbyte Industrial
Compact Flash:	256 Mbyte
USB 2.0:	4 x ports
Network:	1 x Ethernet 10/100 Mbit
X-Channel I:	RS 422/485 2 x ports
X-Channel II:	RS 422/485 6 x ports
Video:	1 x LVDS and 1 x VGA
Touch screen:	1 x TTL port
Keyboard:	1 x PS2 Keyboard port (Unused)
Mouse:	1 x PS2 Mouse Port (Unused)

Communications

Protocol:	X-Channel I and X-Channel II
Network:	RS-422 Multidrop

HV Generators and Amplifiers

Gas Flow HV Generator

A single High Voltage supply, centrally generated by 5713A, is distributed to all Gas Flow detectors. User programmable HV is gas mixture-dependent. Because all 5710A detectors have a long and stable plateau, the 1,700-Volt factory-set default is suitable for all detectors running on P7½ gas mixture.

High Voltage Range:	1200 to 2,200 Volts DC
HV Resolution:	~ ± 5 Volts DC
Default HV Setting:	1,700 Volts DC - 7½% Methane in Argon (P7½)
Current Limit Range:	5 to 50 µA DC
Default Current Limit:	20 µA DC
Output Protection:	22 MΩ Series impedance – Indefinite Short Circuit

Gas Flow Amplifier Thresholds

The Gas Flow Quad Amplifier, type 5704A, has four identical Amplifiers. Each Amplifier channel has four programmable thresholds, effectively creating four energy windows.

Threshold	Range	Step	Default Setting
1	0 – 2000 mV	1 mV	200 mV
2	0 – 2000 mV	1 mV	1700 mV
3	0 – 2000 mV	1 mV	2000 mV
4	0 – 2000 mV	1 mV	2000 mV

CAUTION: ALTHOUGH ALL THRESHOLDS ARE ADJUSTABLE UNDER SOFTWARE CONTROL, SPECIAL PASSWORD AUTHORIZATION IS REQUIRED AND ADJUSTMENT IS NOT RECOMMENDED BECAUSE THE CHANGE IN RESPONSE MAY COMPROMISE MONITORING INTEGRITY.

Scintillation HV Settings

Operating voltages should normally be set up using the NBR Method (page 9-6), although they may also be set up using the Figure of Merit (FOM) Method for Gamma Scintillation Detectors (page 9-7) to yield the optimum Photomultiplier operating voltages. These settings are determined and set using the HV Scan feature (see Calibration|HV Scan (page 5-46) for additional information). The recommended values, based on the NBR optimization method, can be found in the Calibration certificate for each individual instrument.

Scintillation HV Generator

The Scintillation HV/Amplifier, type FHT 681, has two identical HV Generator and Amplifier Channels. Each HV Generator is User programmed to obtain the optimum operating point for individual detectors PMTs.

High Voltage Range: 500 to 1,400 Volts DC

HV Resolution: ~ ±5 Volts DC

Default HV Setting: 700 Volts DC

Scintillation Amplifier Thresholds

The Scintillation HV/Amplifier, type FHT 681, has two identical HV Generator and Amplifier Channels. Each Amplifier channel has four programmable thresholds, effectively creating five energy windows.

Threshold	Range	Step	Default Setting
1	0 – 4095 mV	1 mV	50 mV
2	0 – 4095 mV	1 mV	1000 mV
3	0 – 4095 mV	1 mV	1050 mV
4	0 – 4095 mV	1 mV	1850 mV
5	0 – 4095 mV	1 mV	3000 mV

CAUTION: ALTHOUGH ALL THRESHOLDS ARE ADJUSTABLE UNDER SOFTWARE CONTROL, SPECIAL PASSWORD AUTHORIZATION IS REQUIRED AND ADJUSTMENT IS NOT RECOMMENDED BECAUSE THE CHANGE IN RESPONSE MAY COMPROMISE MONITORING INTEGRITY.

Control

The IPCM12 has minimal user controls for ease of use and reliability.

Power ON/OFF

Keyswitch – momentary “RUN/START” operation

Momentary START position - auto “cold start”

Software Shutdown

10 second START position - “forced shut-down”

Body Position Sensors

Administration mode - *System* menu - *Actions* sub-menu - *Shutdown* Password-protected touch screen - closes Application, shuts down Windows, performs auto hardware auto-power-off

All iPCM variants have seven automatic body sensor photobeams:

Photobeam	Function	Location
Left Foot	Sole - Toe to Heel	Beneath Left Tread Plate
Right Foot	Sole - Toe to Heel	Beneath Right Tread Plate
Left Toe*	Top of Left Shoe/Toe	Behind Left Body Array
Right Toe*	Top of Right Shoes/Toe	Behind Right Body Array
Leg	Side of Leg/Trousers	Vertical Surface Island Assy
Body	Body Torso/Stomach	Mid Body Array - Horiziontal @ 50 mm

* Toe sensors uniquely define correct forward monitoring Position.

Soft Keys Touch screen "Soft Keys" – available to use in some functions

Displays

Color LCD The integral back-lit LCD display provided is used in conjunction with the touch-screen for data entry and diagnostic functions. As well as duplicating any front panel LED display, the LCD also provides comprehensive, user-friendly operational guidance, measurement results, and instrument fault messages.

LCD Resolution:	640 x 480
Backlight:	Dual CCFL
Touch Screen:	Five-Wire

Status Lamps Five LED Cluster Lamps - Instrument Status and User Guidance

One or (optionally) two LED cluster boards, type 5672A

User Guidance Display Dual LED ClusterLamps and Dual Digit Count-Down Timer

User Guidance Display:	Type 5711A
White Lamp:	Face Forwards
Amber Lamp:	Reverse
Digital Display:	0 – 99 Second Count-Down Display

Charging LED Green LED – AC Mains presence and battery charging status

Constantly Lit: The instrument is on and the battery is charging

Slow Flash: The instrument is on and running on battery

Fast Flash: The instrument is off and the battery is charging

Fast/Slow Flash: SOS; there is a battery fault

Audible Indications

Chime	Measurement with a CLEAR result
Single Tone	End of a parameter counting sequence OR Measurement Aborted
Periodic Tones	Operator sequence ERROR
Rapid Tones	Measurement exceeding ALARM ACTIVITY
Dual-Tone Alarm	Measurement exceeding HIGH LEVEL ALARM
Warble	Measurement Aborted

In addition to the audible indications given above, the following voice prompts are given, if enabled (see Setup Menu|UI Options (page 5-9)):

“Enter identification”.	If User ID Required is ticked, the user is requested to enter their ID before entering the portal (see User ID (page 5-94)).
“Illegal Entry – Please leave the portal”.	If User ID Required is ticked and the user enters the portal without entering their ID (see User ID (page 5-94))
“Please return to position”.	If during measurement, the user moves from the specified position (see Violations during Monitoring (page 5-98)).
“Illegal Exit – Please re-enter the portal”.	If the user exits the portal during measurement (see Violations during Monitoring (page 5-98)).
“Clear – Please leave the portal”.	If the measured contamination is below alarm levels, the user is advised to leave the portal (see CLEAR Result (page 5-103)).
“Measurement abandoned”.	If the user exits the portal on the ingress side before the measurement is complete (see Violations during Monitoring (page 5-98)).

"Instrument Out of Service".	If the portal is entered when the unit is out of service, the user is advised to leave the portal (see Out Of Service (page 5-112)).
"Measurement Incomplete. Please re-enter the portal and start again".	If the user exits the portal on the egress side before the measurement is complete (see Violations during Monitoring (page 5-98)).
"Please leave and re-enter the portal to start measurement".	If the user does not fully exit the portal on completion of measurement (see Violations during Monitoring (page 5-98)).

Note: The speaker volume is user adjustable in System|Setup Menu (page 5-9).

Network Communications

An RJ45 network connector is located adjacent to the AC Mains connector in the roof plinth perimeter.

USB Ports

A four-port USB (version 1.1) hub is located immediately below the LCD. Facilitates keyboard, mouse, memory stick, and security dongle connection without requiring key/access to the electronics/service bay.

Services Required

iPCM12A Power Requirements

Voltage	-	85 to 264 Volts AC
Frequency	-	47 to 63 Hz
Maximum power	-	185 V.A.
Circuit Protection	-	Integral Power supply fuse 250V 2A (***Not User serviceable)***
Mains Isolation	-	ON/OFF switch (adjacent to PSU)

iPCM12A Battery Backup †

Battery type	Sealed lead-acid Gel-Cell
Battery capacity	12 volts 17Ah standard (38 Ah Optional)
Battery support	Typically up to ½ hour standard (1 hr Optional)
Battery Fuse	6.3A Slow Blow (5703A)

Counting Gas Requirement

Gas Type: Argon/Methane

Mixture:
- P10 (10% Methane/ 90% Argon)
- P7.5 (7.5% Methane/ 92.5% Argon) Non flammable – recommended
- P5 (5% Methane/ 95% Argon) Non flammable
- (10% Carbon Dioxide/90% Argon) Non flammable

Flow: Minimum 25 cc/min (Beta only operation)

Normally 50 cc/min (Recommended for Peak alpha performance)

Purge: 500 cc/min

Pressure: 14 to 34.5 kP, or

2 to 5 psi, or

0.15 to 0.35 Bar

Consumption:

Gas Bottle Life (days)	Small Bottle (UK) 1.27 m^3	Large Bottle (UK) 6.38m^3
25cc/min (1.5 L/hr)	30 days	175 days
50cc/min (3.0 L/hr)	15 days	87 days

UK Bottle Life - includes initial System purging

Servicing Access

Rear: No access is required from rear of cabinet – allows the iPCM12 to be installed against a wall or back-to-back with another iPCM12.

Front: Front Cabinet Access is required for the hinged array frame to service detectors. The array protrudes 97 mm beyond the base.

Left Side: No direct service access is required to the left side of the cabinet. Clearance of 141 mm is required on left hand side for the vertical detector array frame to hinge open.

Right Side: Clearance of 400 mm is required on right hand side for access to main electronics assemblies (service bay)

Top: Clearance of at least 200 mm is required to access the head detector and door closer mechanisms/adjusters.

Dimensions (Approximate)

Overall Dimensions (Excluding LCD but Including Foot-plate)

	iPCM12A (open)	iPCM12B (Closed)	iPCM12C (closed gamma)
Height	87. 5”/ 2220 mm	87.5”/ 2220 mm	88.5”/ 2240 mm
Width	37”/ 940 mm	37”/ 940 mm	37”/ 940 mm
Depth	29”/ 735 mm	46.5"/ 1330 mm	46.5”/ 1330 mm

Monitoring Area

Height:	2020 mm (max.)
Width of Array:	520 mm
Total Monitoring Area:	15300 cm^2 (basic unit) 16700 cm^2 (with optional detectors)

Weight

iPCM12A – standard open unuit	approx. 300 kg (660 lbs)
iPCM12B – standard closed unit, no doors	approx. 500 kg (1100 lbs)
iPCM12B – with two doors	Approx. 600 kg (1320 lbs)
iPCM12C – includes gamma option and full lead shielding	approx. 1700 kg (3750 lbs)

Shielding for Full Body Gamma – Option IPCM12C

AE0222A:

Detector shielding (all types) – 10 mm low-background lead

Rear/side shadow-shield wall – 20 mm low-background lead

Base shield (whole footprint) – 20 mm low-background lead

Environmental

Temperature and Humidity

Operational Temperature Range	+0°C to +45°C (32°F to 113°F)
Storage Temperature Range	-10°C to +50°C(14°F to 122°F)
Humidity Range	up to 95% RH non condensing

CAUTION: USE BELOW +0°C (32°F) IS NOT RECOMMENDED – THE LCD DISPLAY WILL BECOME "SLUGGISH" BELOW THIS TEMPERATURE.

DO NOT STORE ABOVE +60°C (122°F).

Magnetic Shielding There is no magnetic shielding.

Large external magnetic fields may reduce the measured value.

IP Rating IP50

Environmental Restrictions

- Not for use in flammable or explosive atmospheres
- For installation in "drip-free" locations only
- Do not expose to excessive dust pollution levels

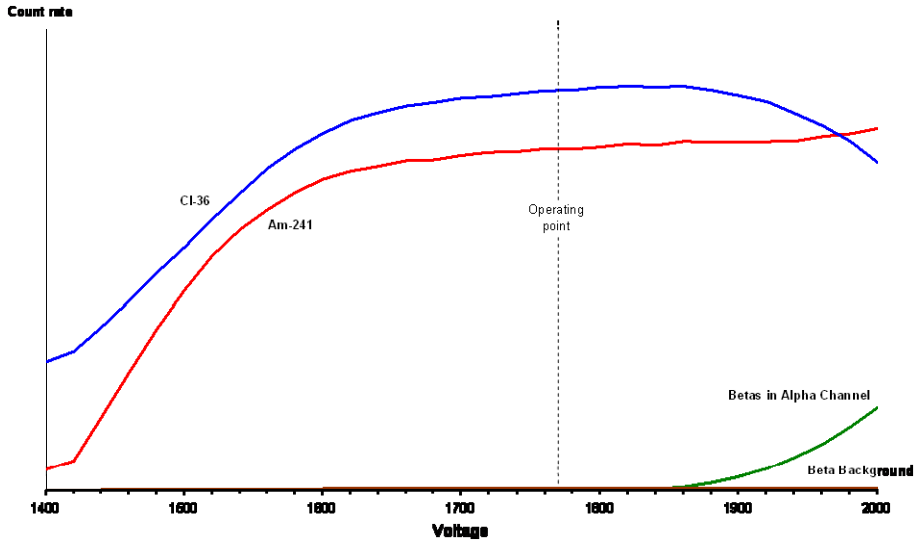


Figure 1 Typical Detector Performance Graph

Chapter 4 Unpacking and Installation

iPCM12A Open Units

Unpacking

WARNING:

OPEN iPCM12 "A" VARIANTS WEIGH APPROXIMATELY 350kg (770lbs).

A FORK-LIFT TRUCK OF SUITABLE LIFTING CAPACITY MUST BE USED TO MOVE AND TRANSPORT THE iPCM12 SAFELY, USING THE INTEGRAL FORK LIFTING FACILITIES.

A LOW-PROFILE PALLET-JACK TRUCK OF SUITABLE LIFTING CAPACITY MAY BE USED TO MOVE OPEN iPCMs LOCALLY OVER FLAT AND EVEN SURFACES - FOR FINAL INSTALLATION AND SERVICING ONLY.

WHEELS, SKIDS, SKATES, AND OTHER DEVICES SHOULD NOT BE USED TO MOVE iPCM12s.

PARTICULAR CARE MUST BE TAKEN ON GRADIENTS AND UNEVEN SURFACES.

iPCM12 with Lead Shielding (Scintillation Options)

iPCM12s TO BE FITTED WITH SCINTILLATION (GAMMA) OPTIONS ARE SHIPPED AS OPEN UNITS – CLOSED EXTENSION, LEAD SHIELDING AND SCINTILLATION DETECTORS ARE SHIPPED SEPARATELY. OBSERVE THE iPCM12 HANDLING INSTRUCTIONS ABOVE.

THE CLOSED EXTENSION, LEAD SHIELDING, AND SCINTILLATION DETECTORS MUST ONLY BE FITTED AFTER THE iPCM12 HAS BEEN INSTALLED IN ITS PERMANENT LOCATION, IN ACCORDANCE WITH THE MECHANICAL INSTALLATION (page 4-5).

iPCM12s FITTED WITH LEAD SHIELDING MUST NEVER BE MOVED AS A COMPLETE ASSEMBLY IN ANY WAY WHATSOEVER! (REMOVE ALL LEAD & DETECTORS FIRST.) DAMAGE TO THE UNIT MAY RESULT.

ENSURE THE INSTALLATION SITE IS LEVEL AND SUITABLY ROBUST.

The iPCM12 is shipped as an "Open" unit - complete with factory fitted Gas Flow detector and small integral options. The Closed cabinet extension, lead shielding, and Scintillation options are shipped in separate packaging.

The iPCM12 "Open" unit packing case will contain the following items:

- Installed Personnel Contamination Monitor type iPCM12A - wrapped in polyethylene
- Combined Operational and Maintenance Manual
- Calibration Certificate
- Keys for Service door cabinet and all hinged panels
- Keys for "Run/Start" (ON/OFF) Key-switch
- Security Dongle for iPCM12
- Set of 2.5 mm, 3 mm, and 4 mm Allen keys
- Foot plinth tread plate lifting tool x 2
- Festo Polyethylene 3mm (PL3) gas tubing (3 lengths)
- Festo Bulkhead Gas Fittings x 2
- IEC power cord – with free end

Scintillation option (AE0222A) will be crated separately as follows:

- Lead shielding: Base tray, Base lead, detector lead, and shadow shield lead.
- Scintillation Detectors: body (6), Hand, Foot, Head (3)

Items Required

The following items will be required to perform the installation:

- Fork lift truck 500 Kg (1,000 lbs) minimum capacity, adjustable gate, and trained driver
- Optionally, a low-profile pallet-jack truck (27" outer gate width)
- Counting gas, preferably 7.5% or 10% Methane in Argon (P7.5 or P10)
- Festo PL3 Gas Tubing (25 m minimum)
- Power source 110 V or 220 V AC – for the iPCM12
- IEC Power cord
- Wire cutters
- Scissors
- USB keyboard (with NO multimedia keys)
- USB Mouse (if touch screen doesn't work)
- VGA monitor (if display doesn't work)
- Gas sniffer (TIF 8800A or equivalent)

Transit Damage Inspection

Inspect the external wooden packaging for signs of transit damage.

Inspect the tilt and shock meters on the front of the packing case for signs of handling abuse – normally clear, these turn red if the package has been tipped significantly or dropped too hard. Record their status if damage is indicated or suspected (ideally photograph).

Unpacking iPCM12

To unpack the iPCM12, remove the top and side packing panels and peel off the polyethylene wrapping.

The iPCM12 should be left on the base pallet until it is at the installation site in order to reduce the risk of damage during transportation. The base is designed to allow easy Fork-Lift access.

The floor of the installation site must be level and suitably robust in order to support the weight of the iPCM12.

When at the installation site the iPCM12 may be lifted off its base, using the fork lifting channels provided, and placed on the floor.

WARNING: CARE MUST BE TAKEN WHEN LIFTING - THE STANDARD iPCM12 WEIGHS 350 kg iPCM12S

FITTED WITH FULL LEAD SHIELDING WEIGH IN EXCESS OF 1300 kg, ARE POTENTIALLY UNSTABLE, AND MUST NEVER BE MOVED IN ANYWAY WHATSOEVER WITH THE LEAD SHIELDING FITTED!

Mechanical installation directions and concerns are covered in

Mechanical Installation (page 4-5).

1. Remove the wood screws using a Phillips head screwdriver on the roof and front (tilt/shock meter side) of the case – assuming these have not already been removed by Customs/IRS.
2. Leave the rear and side panels in position.
3. The front (detector array side) of the IPCM12 exposed is the heaviest face, and it should be forked from this side.
4. Use a Fork-lift of suitable capacity (500 Kg minimum), with the fork gate-width set as wide as possible to just fit outer span of the iPCM12 fork lift channels – this will prevent the iPCM12 from toppling on uneven surfaces.
5. Insert the forks as far as possible into the iPCM12, taking care not to damage the back of the pack, and carefully lift the iPCM12 **just** clear of the base pallet.
6. Manually push/pull the packing case away from the raised iPCM12 – rather than pulling the iPCM12 out with the Forklift.
7. Retain all packaging materials and fixings, etc., for future re-use.
8. Before transporting the iPCM12, ensure that the rear of the unit is against the gate of the fork lift (use a sheet of cardboard to protect the rear of the unit) and that the jib is tilted backwards.
9. Transporting the iPCM12 to the chosen installation site must be done only with a Forklift, especially over uneven surfaces and on gradients. The alternate recommended pallet truck is only intended for use on flat and level ground in the immediate vicinity of the iPCM12 installation. The iPCM12 should be raised only **just** above ground level, to prevent tipping.
10. The iPCM12 Cabinet keys are in a plastic bag, taped to the hand detector assembly.
11. Once installed, remove the transit packaging from inside the iPCM12 as follows:

1. Remove the packing from the Hand Mechanism "wedge" inside the island assembly.
2. Push the body array frame inwards to release the pressure on the lock catches and unlock both top and center catches.
3. CAUTION: Do not leave the keys in the locks – they may fall and damage foot detectors.
4. Open the body detector array assembly and remove the top-of-toe detector packing and the bubble wrap located behind the body detector assembly.
5. The two transit screws in the foot plinth do not need to be removed unless service access is required to this area.
6. Leave the foot-well cardboard foot detector protection in place until the unit is to be demonstrated – to prevent dust, dirt, and punctures.

12. Note packing details and retain all packing for future re-use.

Mechanical Installation

Positioning

For best possible performance it is suggested that the iPCM12 be positioned in the lowest stable background surroundings. High background fields will reduce sensitivity and fluctuating backgrounds may cause false alarms and operational delays during background update periods.

Reasonable ventilation should be provided around the iPCM12, although there are no specific requirements on positioning.

Physical Installation – All iPCM12 Variants

The iPCM12 must be placed on a flat surface with a maximum height deviation of ±2 mm over the length and width of the footprint of the iPCM12. Allow sufficient space around the cabinet for maintenance:

- 392 mm minimum on side (Right hand side if facing an iPCM12A) for Gas and Power chassis access
- 200 mm minimum Top clearance for electronics access and door closer adjustment
- 141 mm minimum on side opposite the gas and power chassis (Left hand side if facing an iPCM12A)

Under normal circumstances, external access to the front and rear of the cabinet is not required, allowing iPCM12s to be installed against a wall or "back-to-back" in multiple installations (See Drawing D92620 for iPCM12A).

iPCM12A Installations

iPCM12A cabinets can be unstable under certain environmental circumstances, such as an earthquake, if installed free standing. Therefore, the following installation procedure details how to fasten the iPCM12 to the floor:

- In order to fasten the iPCM12 to the floor, threaded minimum M8 Diameter HILTI style bolt expansion anchors should be first put into the floor at the install site to correspond to the (8) 12 mm Diameter holes in the fork channels. The choice of length and material brand of anchors should be made by a site planning engineer. Thermo Fisher Scientific only lists the anchors as a suggestion.
- The iPCM12 should then be lowered to the floor and the hex nuts added to the anchors and tightened to the floor.

iPCM12C Installations Fitted with Lead Shielding for Scintillation Options

iPCM12Cs to be fitted with gamma scintillation options are shipped as standard units and the lead shielding and scintillation detectors shipped separately. **Observe the iPCM12 lifting and handling instructions in** Unpacking (page 4-1).

iPCM12s to be fitted with lead shielding (iPCM12C) should ideally be installed against a robust wall or instruments located back-to-back if possible. iPCM12's base MUST be sited in its permanent installation location first **BEFORE** the iPCM12C unit is installed on top of the pan.

Installation of Lead Shielding

Lead shielding must only be installed **AFTER** the iPCM12C is sited in its permanent location and **AFTER** it has been fixed to the base shadow shield pan as described above. All lead shielding supplied is "blued" (lacquered) to seal the surface, but appropriate local health and safety precautions should be observed when handling and lifting lead shielding. A minimum of two people are required to lift and fit the lead sections into the iPCM12 cabinet.

WARNING: iPCM12s FITTED WITH LEAD SHIELDING MUST NEVER BE MOVED IN ANY WAY WHATSOEVER! LEAD SHIELDING MUST BE REMOVED BEFORE TRANSPORTING.

Electrical Installation

Before proceeding with the electrical installation, ensure the iPCM12 has been mechanically installed as described in

Mechanical Installation (page 4-5).

Due to the many possible variations in cable length and installation requirements, the iPCM12 is supplied with an IEC Power Cord with European Color Coded Conductors and a free end.

The iPCM12 is fitted with a standard IEC connector designed to meet the harmonized European standard BS4491≡EN60320. When selecting a suitable power connector, only IEC sockets complying with this standard should be used.

The Mains port and network ports are located on the top of the iPCM12. Refer to D92620 for a detailed picture.

The iPCM12 is fitted with an auto-ranging switch mode power supply. When selecting a suitable power cable and installation point, the electrical supply must adequately meet the following requirements:

Input Voltage :	85 - 264V~
Input Power :	360 V.A.~
Input Frequency :	45 - 440Hz
Fuse:	T3.15A 250V~

The mains inlet to the iPCM12 is located on the top of the unit. The location is detailed in drawing D92620.

WARNING: IN CASE OF EMERGENCY, IT IS IMPORTANT TO INSTALL THE MAINS ON/OFF SWITCH CLOSE TO THE EQUIPMENT IN EASY REACH OF THE OPERATOR. IT SHOULD BE LABELLED AS THE SYSTEM DISCONNECTING DEVICE.

WARNING: ENSURE THE MAINS CABLE IS ISOLATED FROM THE MAINS AT SOURCE AND THE iPCM12 POWER SWITCH IS IN THE O (OFF) POSITION BEFORE CONNECTING TO THE MAINS INLET.

The remaining end of the mains cable should be wired using the following color code:

BROWN	-	LIVE
BLUE	-	NEUTRAL
GREEN/YELLOW	-	EARTH

The BROWN wire must be connected to the “L”, “LIVE” or red terminal. The BLUE wire must be connected to the “N”, “NEUTRAL” or black terminal. The GREEN/YELLOW wire must be connected to the “E”, “EARTH”, “GROUND”, or green/yellow terminal.

WARNING: THE iPCM12 MUST AT NO TIME BE OPERATED WITHOUT THE GREEN/YELLOW WIRE CONNECTED TO THE MAINS EARTH.

Refer to Operating Instructions (page 5-1) before switching on iPCM12.

GAS System Installation

The iPCM12 requires Supply and Exhaust connection for the counting gas supply.

Gas Mixture

The iPCM12 requires a counting gas supply in one of the following mixtures:

- P5* (5% Methane-/95% Argon) Non flammable
- P7½* (7.5% Methane/92.5% Argon) Non flammable - recommended
- P10* (10% Methane/90% Argon)
- 10% Carbon dioxide/90% Argon*
- 20% Carbon dioxide/80% Argon* - not recommended.

* See Quad Gas Flow α/β Detector Type 5710A (page 2-12) Operational Voltage settings.

Gas Connections

iPCM12 gas services are via bulkhead connections located in the top Right corner of the Gas chassis. “Inlet” and “Exhaust” bulkhead connections are for Festo Polyethylene PL3 tubing (4.3 mm O.D / 3.0 mm I.D). A Festo Polyethylene supply system is recommended for distributing gas directly from the regulator to all iPCM12s, if site is equipped with multiple iPCM12s. Because the normal operational flow rate is only 25-

50 cc/min, a large number of iPCM12s can be supplied with a single PL3 network. Alternatively, Nylon or stainless steel distribution systems can be used provided compression fittings are used exclusively throughout and the system is free from grease, lubricants, flux, and other contaminants.

WARNING: DO NOT USE COPPER, SOLDER JOINTS, FLUX, OR OTHER MATERIALS INCLUDING SILICON/RUBBERS AND POLYURETHANE.

The iPCM12 "Exhaust" gas Bulkhead connector is suitable for Festo Polyethylene PL3 tubing (4.3 mm O.D / 3.0mm I.D). While the exhaust gas is not toxic and both P5 and P7½ are non flammable, it should be piped well away from the iPCM12, ideally outside the building. This is necessary because exhaust gas in the vicinity of the iPCM12 makes leak detection with a gas sniffer impossible. In any case, a minimum of 10 meters (30 feet) of tubing should be attached to the "Exhaust" Bulkhead. This effectively creates a gas reservoir, which prevents air from being drawn back into the system in the event of the internal gas volume shrinking due to sudden temperature drop, e.g., due to external doors opening. **Observe the Warning above.**

Gas Pressure

The gas supply pressure must be externally regulated, usually by a regulator at the gas bottle. The input pressure to the iPCM12 must be regulated to between 14 and 34.5 kPa /2 to 5 psi/ 0.15 to 0.35 Bar. The flow rate through the iPCM12 gas circuit is controlled by a flow control valve located on the gas chassis. This can be accessed through the GUI Setup detailed Gas Flow (page 5-22). The pressure within the iPCM12 gas system is very low – a few mm water gauge.

Purging the System

On initial installation and after a major repair the entire gas system must be thoroughly purged of all air.

To do this, the security dongle must be inserted into the system USB to access the setup screens on the LCD. Once in the setup screens, select "Diagnostics" on the top tab. From there, select "Gas Flow". A series of inlet flow and exhaust flow rates are shown. There is a dialog box with radio buttons stating: "Normal" and Purge". Select the "Purge" box and the system will begin to purge. These instructions are detailed in Diagnostics Menu (page 5-27) and Gas Flow (page 5-22).

NOTE: Purging with the restrictor bypassed (purge Switch ON) at flow rates up to 500 cc/min is permissible. Do not exceed 500 cc/min or detector window damage may result.

Purge the system at between 300 and 500 cc/min for at least two hours to ensure all air is flushed from the system. Rapid purging is recommended, because this creates turbulence within the detector volume, which tends to disperse air pockets.

The iPCM12 is now ready for use. Read the following section regarding the normal operational flow rate issues.

It will take sometime for the outlet flow to settle down to that of the inlet flow. In a reasonably leak-free system, the inlet and outlet flow meters should read within ~10%. In some circumstances, (elevated temperatures) the outlet flow may appear to be greater than that of the inlet, which is normal.

Gas Flow Rate – Normal Operation

Gas consumption and flow rates are very low. Flow rates involved are a few tens of ccs per minute (a small fraction of human lung capacity) and just sufficient to maintain the gas mixture quality against any minor air ingress.

A nominal flow rate of 50 cc/min (3 L/hr) is recommended. This is sufficient to overcome any minor air ingress due to micro-porosity of the window foils and small leaks (pin size hole), while maintaining peak alpha and low energy beta efficiency.

A minimum flow rate of 25 cc/min (1.5 L/hr) is required in leak-free beta only detection systems.

Flow rates below 25 cc/min are not recommended, because flow-meter calibration below 50 cc/min is non-linear and of questionable accuracy. Also, too low of a flow through the system will result in air ingress and reduction in counting efficiency – particularly alpha efficiency.

The flow rate should not exceed 100 cc/min with the restrictor in-circulate (purge switch OFF). Leaks should be repaired as soon as possible.

Orientation and Positioning of the iPCM12 with Scintillation Detection Option (AE0222A) Known as iPCM12C

Choice of Location

While gas flow proportional counters have a high gamma rejection, the large area Plastic Scintillation detectors fitted in the above options are very sensitive to high levels and changes in the gamma background. Therefore, it is recommended that the installation site be chosen for lowest possible stable background to minimize the effect of statistical fluctuations. See Background Capability (page 3-3) for the background capability of the iPCM12C.

It is recommended that the iPCM12C be installed away from active areas to suit both these needs.

Optimum Orientation within Directional Background Fields

If the background field at the installation site is directional, it is recommended that the iPCM12 be installed so that the front of the Cabinet faces the field source. This orientation should minimize the penetration and scatter of background radiation around the inlet and exit apertures.

Chapter 5 Operating Instructions

Operational States

There are two operational states for the **iPCM12**:

ADMINISTRATOR Mode – this mode allows the instrument to be configured and calibrated and for diagnostic checks to run. Access to this state requires a username and password. See Administrator Mode (below) for further details.

USER Mode – this mode supports the normal monitoring of personnel. Any user can operate the instrument in this state. See User Mode (page 5-82) for more details.

Administrator Mode

NOTE: Communication with the iPCM12 is via a touch screen and this manual primarily gives instructions for entering touch screen commands. It is also possible to use a USB keyboard and mouse to communicate with the iPCM12.

Using the Touch Screen Functions

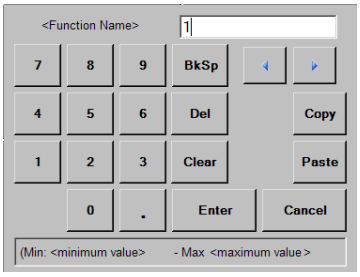
This section describes the methods that are common to all the entry and data viewing operations in the Parameter Mode menus.

When using the touch screen, directly touch the menu options on the screen when selecting a function.

CAUTION: IT IS ADVISED TO USE A CLEAN FINGER TO TOUCH THE SCREEN. DO NOT USE SHARP OBJECTS ON THE TOUCHSCREEN SUCH AS PENCILS, PENS, SCREWDRIVERS, ETC.

Number Functions

When touching the screen in a numerical field, the following number pad appears:

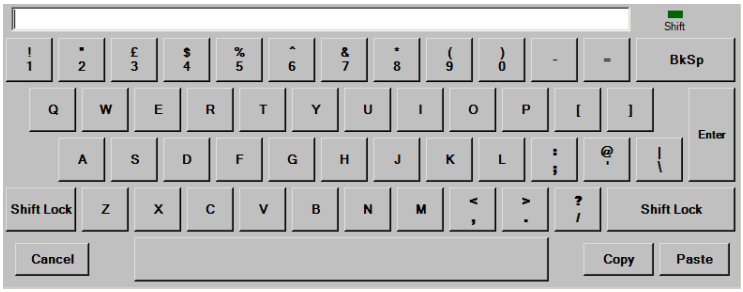


NOTE: The Function Name, minimum and maximum values displayed depend on the function selected.

If an illegal value is entered, the value is highlighted in red:

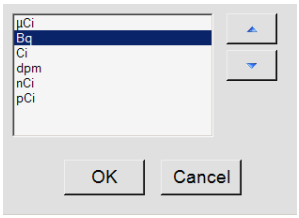
Alpha-numerical Functions

When touching the screen in an alpha-numerical field, the following keyboard appears:



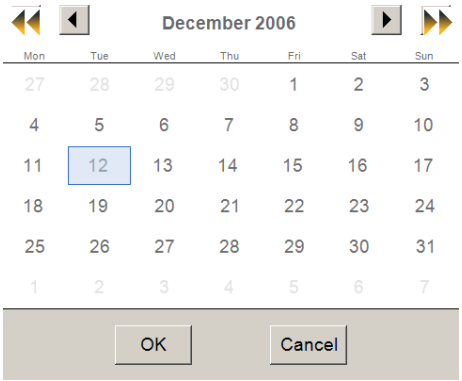
Pre-defined Functions

When touching the screen in a pre-defined field, the following window appears:



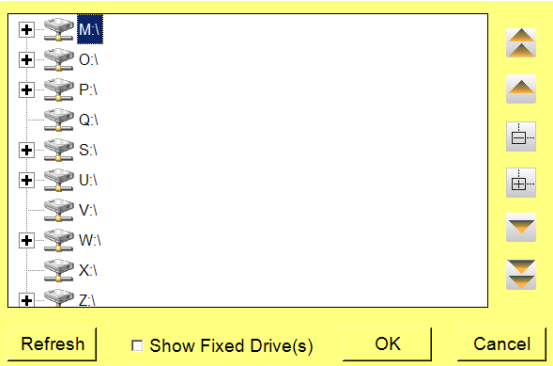
Date Functions

When touching the screen in a date field, the following date selection window appears:



File Location Functions

When touching the screen in a File Location field, the following Drive selection window appears:



Button Types

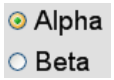
The Button types are listed below:

Direction Arrows step through the menu options

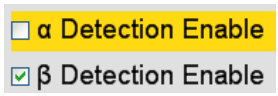
Drop-down lists allow you to select a pre-defined option from the list.

Action buttons show the process taken when selected.

Tick Boxes show independent options that you can choose to set, or mark. The choice can be toggled on and off by touching on the box.



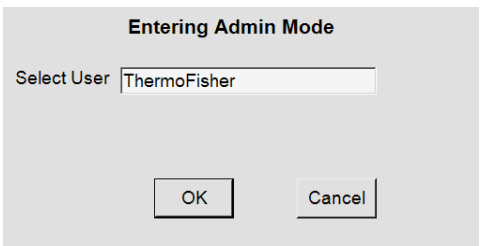
Radio Buttons show mutually exclusive options; choosing one option automatically clears the others. The black dot shows the selected option.



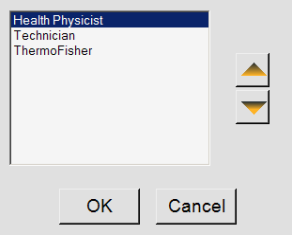
Note that changes made to fields are highlighted until applied or cancelled.

Gaining Access to the Administration Mode

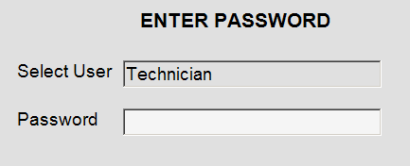
Administration mode is entered by pressing on 'iPCM-12' in the bottom left-hand corner of the touch screen when the iPCM12 is in Background Checking mode. The Entering Admin Mode window requesting a User selection displays:



To select a different user to the one displayed, press the select User field of the touch screen. Select Health Physicist, Technician, or ThermoFisher using the Up/Down arrow and select OK. See Foreword (page xv) for more information regarding the roles.

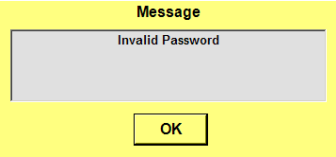


In the Entering Admin Mode window, select OK for the ENTER PASSWORD window (see below); the Alphanumeric keyboard displays:



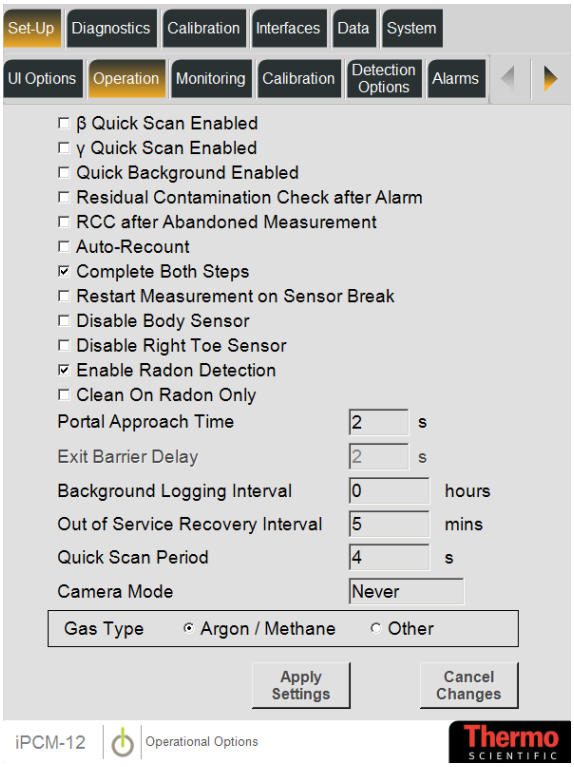
Enter the password using the keyboard and select OK to enter the Administration Mode. Note that the Diagnostics – Detector window initially displays (see Passwords (page 5-80) for details). The various options available in the Administration Mode displays in Menu Roles (page 5-7).

Entering an invalid password will display the following message:



Press OK to re-display the Enter Admin Mode screen.

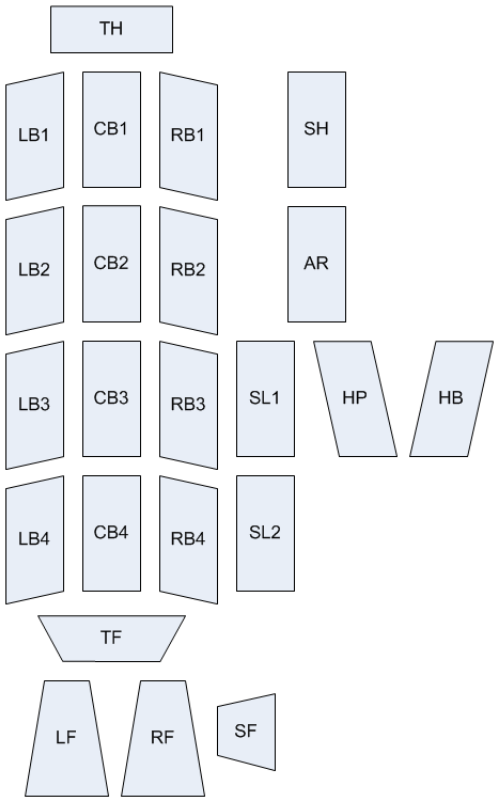
Moving through the Menus



To move through the menus, select the Main menu option on the top line to display the sub-menus available. Then select the sub-option from the second line. A full list of menu and sub-menu options displays in Menu Roles (below).

Selecting Detectors

On some screens, an option is available to select Detectors. To select individual Detectors, press the corresponding designation in the graphic:



TH	Top of Head
LB1	Left Body (Top)
CB1	Centre Body (Top)
RB1	Right Body (Top)
SH	Side of Head / Shoulder
LB2	Left Body (Upper Middle)
CB2	Center Body (Upper Middle)
RB2	Right Body (Upper Middle)
AR	Upper Arm
LB3	Left Body (Lower Middle)
CB3	Center Body (Lower Middle)
RB3	Right Body (Lower Middle)
SL1	Side of Leg Upper
LB2	Left Body (Bottom)
CB4	Center Body (Bottom)
RB4	Right Body (Bottom)
SL4	Side of Leg Lower
HP	Hand Palm
HB	Hand Back
TF	Top of Foot
LF	Left Foot Sole
RF	Right Foot Sole
SF	Side of Foot

For further information regarding Detectors, see Scintillation Gamma Detectors Type 5708A and 5717A (page 2-14).

Menu Roles The following options are available depending on the role selected:

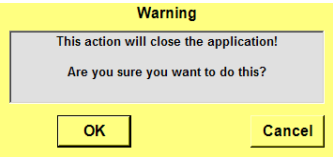
			Role Name		
Main Menu	**Sub-menu**	**See Page**	**Health Physicist**	**Technician**	**Thermo Fisher**
Set-Up	UI Options	5-9	✓		✓
	Operation	5-11	✓		✓
	Monitoring	5-14	✓		✓
	Calibration	5-16	✓		✓
	Detection Options	5-17	✓		✓
	Alarms	5-19	✓		✓
	X-Channel	5-20	✓		✓
	Battery	5-21	✓		✓
	Gas Flow	5-22	✓		✓
	Barriers	5-23	✓		✓
	Messages	5-25	✓		✓
	HV Gen	5-26	✓		✓
	Radon	5-26	✓		✓
Diagnostics	Detectors	5-27	✓	✓	✓
	Timed Counts	5-29	✓		✓
	Information	5-29	✓	✓	✓
	Alarm Check	5-31	✓	✓	✓
	Position Sensors	5-31	✓	✓	✓
	Variance Test	5-32	✓		✓
	Attenuation	5-34	✓		✓
	Lamps	5-34	✓	✓	✓
	HV Gen	5-35	✓	✓	✓
	Battery Charger	5-36	✓	✓	✓
	Barriers	5-36	✓	✓	✓
	Gas Flow	5-37	✓	✓	✓
Calibration	Efficiencies	5-38	✓	✓	✓
	Cal Status	5-38	✓		✓
	Cal Check	5-39	✓	✓	✓
	Cal Streams	5-45	✓	✓	✓
	HV Scan	5-46	✓		✓
	Attenuation	5-53	✓		✓
	Thresholds	5-54			✓
	Sources and Fixtures	5-55	✓		✓

			Role Name		
Main Menu	Sub-menu	See Page	Health Physicist	Technician	Thermo Fisher
Interfaces	Plug-ins	5-57	✓		✓
	Camera	5-62	✓	✓	✓
Data	Reports	5-63	✓		✓
	Archives	5-77	✓		✓
System	Actions	5-78	✓	✓	✓
	Setup	5-79	✓	✓	✓
	Version	5-80	✓	✓	✓
	Passwords	5-80	✓		✓
	Data Retention	5-81	✓		✓

Exiting the Administration Mode

To exit Administration mode, press on 'iPCM-12' in the bottom left-hand corner of the touch screen. Login to the Administration mode – see Gaining Access to the Administration Mode (page 5-3).

Select the System main menu option and select the Actions sub-menu option. Select the Exit Application button. A warning message asking for confirmation displays:



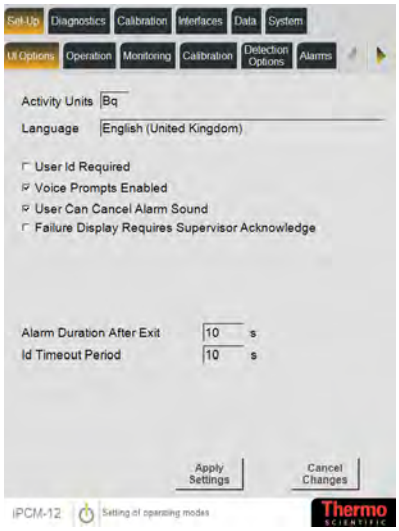
Select OK to exit and Cancel to abandon the exit process. For, more information, see Actions (page 5-78).

Upon exiting from the Keypad Parameter Mode, a Cold Start mode will run if the configuration has been changed – see Cold Start State (page 5-85).

Setup Menu

UI Options

Select Set-Up|UI Options to customize the iPCM12's operation:



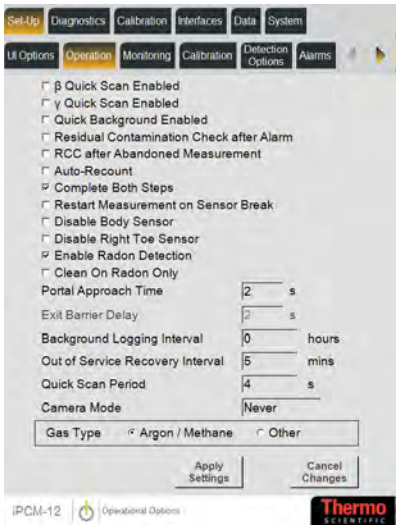
Description of options:

Field Name	Description
Activity Units	Use the pre-defined window to select a unit from one of the following: • dpm • Bq • kBq • pCi • nCi • µCi • mCi • Ci This changes the displayed activity units for the iPCM12. Default: dpm
Language	Use the pre-defined window to select a language. This changes the displayed language for the iPCM12.
User Id Required	This option ensures that the user must enter his or her ID using the barcode reader before the portal will operate. The following message displays: Enter Id and then Enter See User ID (page 5-94) for information on how this is implemented in the Monitoring process. Default: OFF

Field Name	Description
Voice Prompts Enabled	Tick this option to enable voice prompts to be audible. For more information regarding the prompts and where they are used, see Audible Indications (page 3-16). Default: OFF
User Can Cancel Alarm Sound	This option allows the user to press the Alarm Acknowledge button when an alarm has taken place. See Cancel Alarm (page 5-108) for more information on clearing the alarms. Default: OFF
Failure Display Requires Supervisor Acknowledge	This option ensures that a supervisor has to insert a dongle and press the Alarm Acknowledge button when a failure (or alarm) has taken place. The alarm will continue to display and sound until the supervisor acknowledges it. See Cancel Alarm (page 5-108) for more information on clearing the alarms. Default: OFF
Alarm Duration After Exit	This is the length of time that the alarm displays/sounds after the user has exited the portal. See Cancel Alarm (page 5-108) for more information on clearing the alarms. Values: 0 to 300 s Default: 2 seconds
Id Timeout Period (s)	This is the maximum length of time allowed between entering the User ID and entering the portal. It is also used as the maximum length of time (in seconds) allowed for the user to present their ID after entering the portal. *User Id Required (see above) must be ticked for this option to be effective.* Values: 0 to 300 s Default: 10 seconds

Operation

Select Set-Up|Operations to customize the iPCM12's operation:



Description of options:

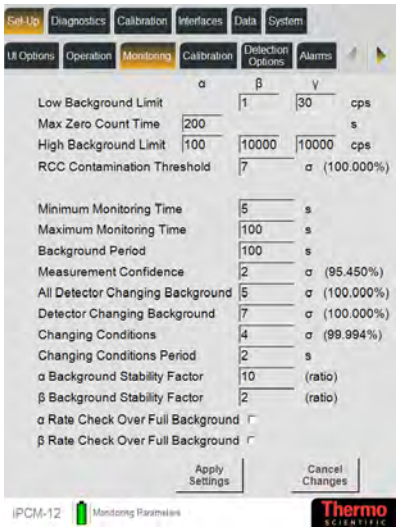
Field Name	Description
β Quick Scan Enabled γ Quick Scan Enabled	These options must be enabled to allow "real-dirty" or "real-clean" identification before the end of the monitoring period. Also, see Quick Scan Period below. Default: OFF
Quick Background Enabled	Tick this option to reduce the time taken to establish a background, i.e., background is considered valid as soon as alarm requirements are met. If this option is not ticked, the time taken to establish a background is 100 seconds. Default: OFF
Residual Contamination Check after Alarm	Tick this option to enable a Residual Contamination Check to perform automatically following an Alarm. For more information regarding Residual Contamination Checks, see Residual Contamination Check (page 5-108).
RCC after Abandoned Measurement	Tick this option to enable a Residual Contamination Check to perform automatically following an abandoned measurement (see Violations during Monitoring (page 5-98)). For more information regarding Residual Contamination Checks, see Residual Contamination Check (page 5-108).
Auto-Recount	Tick this option to enable an automatic recount to take place if the measurement recorded as an alarm.
Complete Both Steps	During a measurement, the first step has the user face the detector array and the second step has the user rotate 180 degrees to face away from the detector array. Tick this option for the user to perform the second step of the measurement.

Field Name	Description
Restart Measurement on Sensor Break	Tick this option to re-start a measurement if the user moves and breaks the sensor (see Position Sensors (page 5-31)).
Disable Body Sensor	Tick this option to disable the Body Sensor (see Position Sensors (page 5-31)).
Disable Right Toe Sensor	Tick this option to disable the Right Toe Sensor (see Position Sensors (page 5-31)).
Enable Radon Detection	Tick this option to enable Radon Detection (see Radon (page 5-26)).
Clean On Radon Only	Tick this option to reject certain Radon specific events (see Radon Rejection (page 6-9) for further information).
Portal Approach Time (s)	This is the maximum length of time following entry to the portal that the user has to move to the correct position in the portal. Values: 0 to 300 s Default: 2 seconds
Exit Barrier Delay (s)	This is the maximum length of time that the user has to re-position him/herself in the portal following exit or illegal movement during measurement. Values: 0 to 300 s Default: 2 seconds
Background Logging Interval (hours)	Select an interval between 1 and 168 hours for the iPCM12 log the background periodically. Select 0 to disable the periodic logging. *Each time a mandatory 100-second background is performed the background for each detector is logged to the database.* Values: 1 to 168 hours (0 to disable) Default: 0
Out of Service Recovery Interval (mins)	When the unit is Out of Service (see Out Of Service (page 5-112), the system automatically clears the error after the Out of Service Recovery Interval has passed. Select 0 to disable the Recovery Interval. Values: 0 to 60 mins Default: 0

Field Name	Description
Quick Scan Period (s)	This option may be enabled to allow "real-dirty" or "real-clean" to be identified before end of monitoring period. Also, see Quick Scan Period in Calibration (page 5-16). Quick Scan is disabled during automatic and manual recounts. This is the length of time (in seconds) for the Quick Scan to run (see UI Options (page 5-9)). Values: 3 to 60 s Default: 10 s
Camera Mode	*Note that this option is only available if camera(s) have been installed (see Camera (page 53)) – it is not displayed in the picture above.* The camera(s) can be set to save a snapshot on the hard drive on entry to the portal. The image of the person is saved to the hard drive only on a successful measurement – if the person aborts the measurement, e.g., by reversion out of the portal, the image is discarded. Use the pre-defined window to select an option from one of the following: · Never – a snapshot will never be taken of the user · On Alarm – a snapshot of the user will only be taken if an alarm occurs · Always –a snapshot of the user will be taken for all results Default: Never
Gas Type	Select a Gas Type from one of the following radio buttons: · Argon / Methane · Other

Monitoring

Select Set-Up|Monitoring to customize the first set of Operational Parameters:



Description of options:

Field Name	Description
Low Background Limit β γ (cps)	If a background measurement falls below this value (counts per second), a detector failure will occur. Values: 0 to 99,999 cps (0 to disable) Default: 50 cps
Max Zero Count Time α (s)	If no counts are received within the Max Zero Count Time, the instrument will go "Out of Service" with a Low Alpha Background. Values: 0 to 99,999 cps (0 to disable) Default: 50 cps
High Background Limit α β γ (cps)	If a background measurement goes above this value (counts per second), a detector failure will occur. Values: 0 to 99,999 cps (0 to disable) Default: 10000 cps
RCC Contamination Threshold (σ)	This is the statistical increase during a Residual Contamination Check compared to the background measurement. *The RCC Contamination Threshold is also expressed as a percentage in parentheses.* Values: 0.1 to 7 sigma in 0.1 sigma steps Default: 7 σ
Minimum Monitoring Time (s)	*The Minimum monitoring time must be equal to or less than Maximum Monitoring Time.* This is the Minimum contamination monitoring. This field is used in conjunction with the Maximum Monitoring Time. Values: 3 to 300 s Default: 5 s

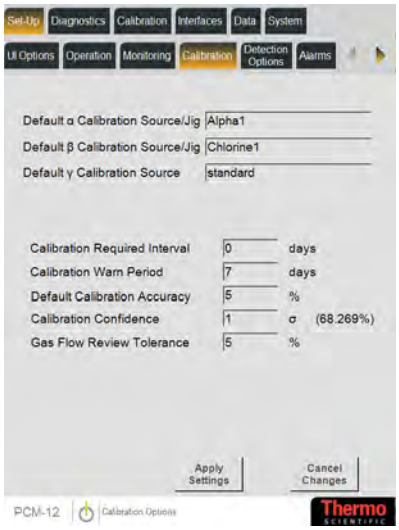
Field Name	Description
Maximum Monitoring Time (s)	*The Maximum monitoring time must be equal to or greater than Minimum monitoring time. It must be set to a high enough value to prevent a high background fault.* This is the Maximum contamination monitoring time. A monitoring time is calculated by the iPCM12 to meet the background and the statistical requirements. For given alarm and statistical requirements, this parameter will limit the background count-rate allowed. To achieve a fixed monitoring time, set the minimum and maximum monitoring times to the same value. Values: 3 to 300 s Default: 100 s
Background Period (s)	This is the current background period. The value is set at 0 if a background has not been acquired.
Measurement Confidence (σ)	The instrument uses this figure to calculate the effective alarm level. It is the number of standard deviations measured against the Alarms (see Alarms (page 5-19)). *The Measurement Confidence is also expressed as a percentage in parentheses.* Values: 0.1 to 10 sigma in 0.1 sigma steps Default: 2 σ
All Detector Changing Background (σ)	This statistical variable is used by iPCM12 to determine if a changing background condition exists on all detectors. *The All Detector Changing Background is also expressed as a percentage in parentheses.* Values: 0.1 to 7 sigma in 0.1 sigma steps Default: 5 σ
Detector Changing Background (σ)	This statistical variable is used by iPCM12 to determine if a changing background condition exists on a single detector. *The Detector Changing Background is expressed as a percentage in parentheses.* Values: 0.1 to 7 sigma in 0.1 sigma steps Default: 7 σ
Changing Conditions (σ)	This statistical variable is used by iPCM12 to determine if a changing measurement condition exists. *The Changing Conditions are expressed as a percentage in parentheses.* Values: 0.1 to 7 sigma in 0.1 sigma steps Default: 7 σ

Field Name	Description
Changing Conditions Period (s)	This is the length of time used by iPCM12 to determine if a changing measurement condition exists. Values: 2 to 30 s Default: 3 s
α Background Stability Factor (ratio)	The stabilization routine triggers when any single detector has a background count that is outside limits defined by the current average and these Background Stability Factors.
β Background Stability Factor (ratio)	
α Rate Check Over Full Background	Tick this option to enable a rate check to occur during a full background count.
β Rate Check Over Full Background	

For more information regarding these options, contact Thermo Fisher Scientific.

Calibration

Select Set-Up|Calibration to customize the Calibration Parameters:



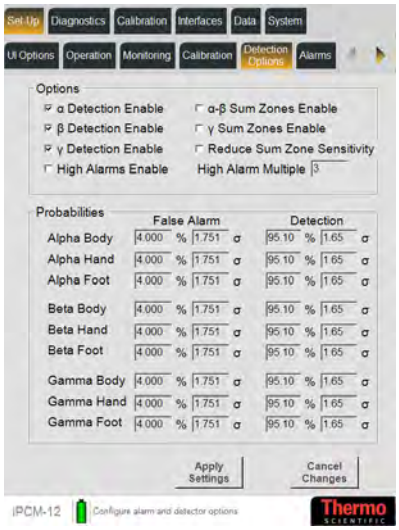
Description of options:

Field Name	Description
Default α Calibration Source/Jig	Use the pre-defined window to select a Calibration Source/Fixture. These Sources/Fixtures are setup in the Calibration|Sources and Fixtures (page 5-55).
Default β Calibration Source/Jig	
Default γCalibration Source	
Calibration Required Interval (days)	The number of days since that last calibration date before the unit needs to be calibrated again. See Out of Calibration (page 5-88) to view the message displayed on the unit when out of date and Cal Check (page 5-39) for information of the last Calibration Date.

Field Name	Description
	Values: 1 to 400 days (0 to disable) Default: 0
Calibration Warn Period (days)	The number of warning days that will be given to the user that the unit needs to be calibrated again. See Out of Calibration (page 5-88) to view the message displayed on the unit when out of date and Cal Check (page 5-39) for information of the last Calibration Date. Values: 1 to 400 days (0 to disable) Default: 0
Default Calibration Accuracy (%)	*This is a view only field.* The default Calibration Accuracy used in the Calibration Check utility - see Cal Check (page 5-39). It is used, along with the background measurement, determines the count time required with the iPCM12 is being calibrated. Values: 0.5 to 10% in 0.1% steps Default: 1.00 %
Calibration Confidence (σ)	*This is a view only field.* *This factor affects the monitoring time of calibration.* *Values: 0.1 to 4 sigma in 0.1 sigma steps* *Default: 2*
Gas Flow Review Tolerance (%)	*If the percentage difference for the α and β detectors between the current and previous calibration is more than this value, the calibration is to be reviewed.* *Values: 5 to 100%* *Default: 5*

Detection Options

Select Set-Up|Detection Options to customize the Alarm and Detection compare Options:

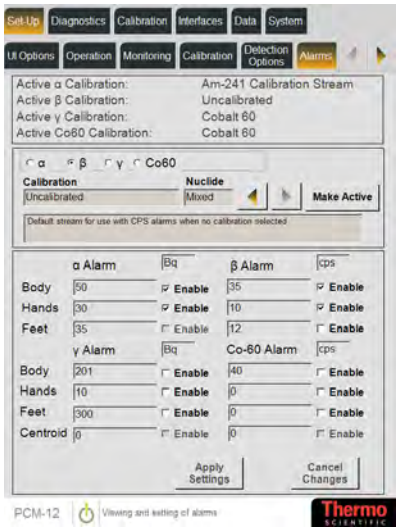


Description of options:

Field Name	Description
α Detection Enable	Tick this option to enable α detection.
β Detection Enable	Tick this option to enable β detection.
γ Detection Enable	Tick this option to enable γ detection.
High Alarms Enable	Tick this option to enable High Level alarms. Default: OFF
α-β Sum Zones Enable	Tick this option to enable two zones added together. See Zone Summation (if required) (page 6-17) for more information.
γ Sum Zones Enable	Tick this option to enable the γ zones to sum together.
Reduce Sum Zone Sensitivity	Tick this option to decrease the sensitivity when Sum Zones is ticked.
High Alarm Multiple	Enter a multiple against the normal alarms levels at which the high alarm levels will detect. Values: 1 to 1000 Default: 5
Probability of False Alarm (% and σ) for: Alpha Body Alpha Hand Alpha Foot Beta Body Beta Hand Beta Foot Gamma Body Gamma Hand Gamma Foot	This value is the probability that a false alarm will NOT be given during a measurement. This probability is used by iPCM12 to determine the monitoring time and the Effective Alarm Level and Minimum Detectable Activity. For further information, see Description of Parameters Used in Calculations (page 6-10). The Probability of False Alarm is expressed as a percentage in parentheses. Values: 0 to 10 sigma in 0.1 sigma steps Default: 3.1 σ
Probability of Detection (% and σ) for: Alpha Body Alpha Hand Alpha Foot Beta Body Beta Hand Beta Foot Gamma Body Gamma Hand Gamma Foot	This is the probability that exactly one alarm Level of contamination will cause an alarm. For further information, see Description of Parameters Used in Calculations. The Probability of Detection is also expressed as a percentage in parentheses. Values: 0 to 10 sigma in 0.1 sigma steps Default: 1.65 σ

Alarms

Select Set-Up|Alarms to select the Active Calibration Stream and set the alarms:



Description of options:

Field Name	Description
α β γ Co60	These values display if they are selected in the Detection Options (page 5-17). Select a Radiation Type in order to activate a Calibration.
Calibration / Nuclide	Use the direction arrows to change the Calibration type. When the type is correct, select the Make Activate button. A description of the Calibration Type displays in the field below.
α Alarm for: · Body · Hands · Feet	This is the detected activity at which iPCM12 will indicate an Alarm. Tick the Enable box to enable the alarm. Values: 0 to 10,000,000 (Any unit)
β Alarm for: · Body · Hands · Feet	This is the detected activity at which iPCM12 will indicate an Alarm. Tick the Enable box to enable the alarm. Values: 0 to 10,000,000 (Any unit)
γ Alarm for: · Body · Hands · Feet · Centroid	This is the detected activity at which iPCM12 will indicate an Alarm. Tick the Enable box to enable the alarm. Values: 0 to 10,000,000 (Any unit)
Co60 Alarm for: · Body · Hands · Feet · Centroid	This is the detected activity at which iPCM12 will indicate an Alarm. Tick the Enable box to enable the alarm. Values: 0 to 10,000,000 (Any unit)

To Activate the Alarm:

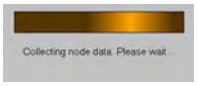
1. Select α, β, γ or Co60.
2. Select a Calibration type using the Left and Right Arrows.
3. Select an Alarm rate from the drop-down box (e.g. Activity Units or cps).
4. Enter the Alarm levels for Body, Hands, Feet, and Centroid (if displayed).
5. To use this alarm for Calibration, select the Active button.

XChannel

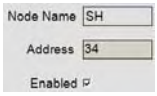
NOTE: This section is set at production and should only be changed in consultation with Thermo Fisher Scientific.

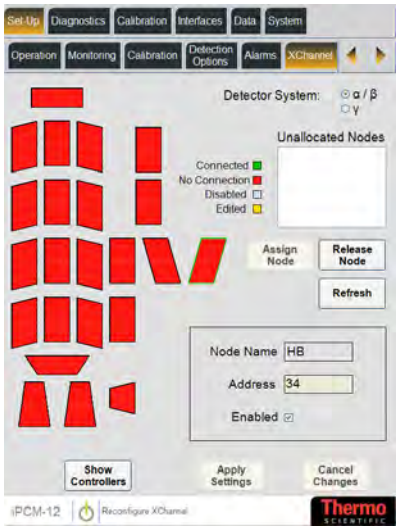
Select Set-Up|XChannel to configure the XChannel:

The following message displays while node data is being collected:

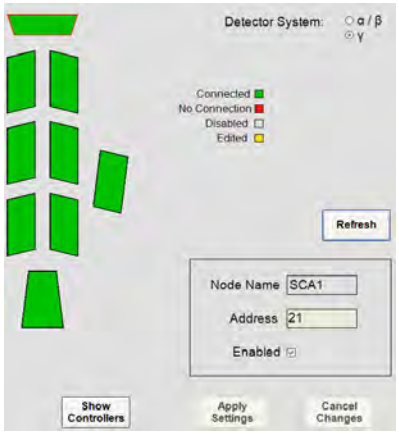


As each node is selected, its data displays:

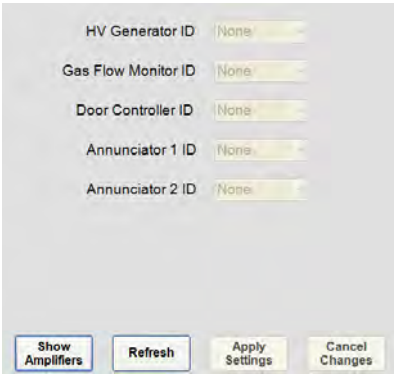




Press the γ option to display the gamma detectors:



Press the Show Controllers button to view the Controllers details:



Battery

Select Set-Up|Battery to configure the Battery Charger.

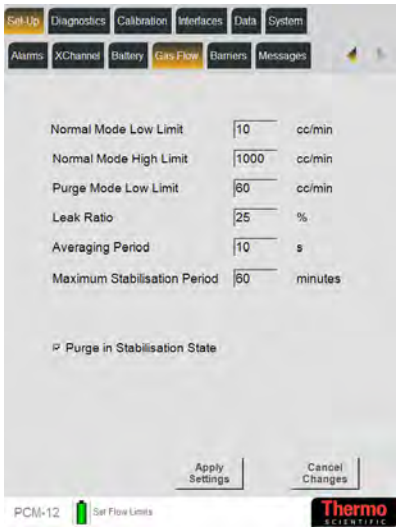
NOTE: This section is set at production and should only be changed in consultation with Thermo Fisher Scientific.

Description of options:

Field Name	Description
Discharge Timeout (s)	This is the amount of time after the battery discharges to the minimum discharge voltage before the charger turns off the output power. If the charger is already running on battery power, the value of the timeout will not change. The timer can only be stopped if the mains power is returned.
Max. Charge Current (A)	This is the maximum current allowed for charging the battery. The charge current is monitored constantly and the PSU output voltage is reduced if this current is exceeded.
Min. Discharge Voltage (V)	This is the voltage at which the timer starts when the battery is being discharged.

Gas Flow

Select Set-Up|Gas Flow to configure the Gas Flow:



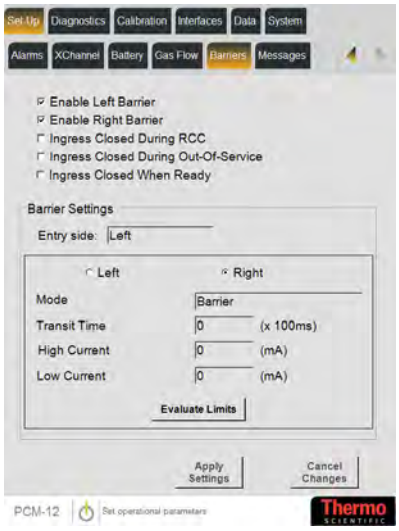
NOTE: This section is set at production and should only be changed in consultation with Thermo Fisher Scientific.

Description of options:

Field Name	Description
Normal Mode Low Limit (cc/min)	If the Gas Flow falls below this limit, the iPCM12 becomes out of service (see Out Of Service (page 5-112)). Values: 0 to 1000
Normal Mode High Limit (cc/min)	If the Gas Flow goes above this limit, the iPCM12 becomes out of service (see Out Of Service (page 5-112)). Values: 0 to 1000
Purge Mode Low Limit (cc/min)	If the Gas Flow falls below this limit when in Purge Mode, the iPCM12 becomes out of service (see Out Of Service (page 5-112)). Values: 0 to 1000
Leak Ratio (%)	Enter the ratio of gas exhaust rate over the gas inlet rate. If this ratio is exceeded, the iPCM12 becomes out of service (see Out Of Service (page 5-112)).
Averaging Period (s)	Enter the smoothing period used to determine the rate figures. This will eliminate the peak rates that occur during normal operation. Values: 2 to 10
Maximum Stabilisation Period (minutes)	Maximum time that instrument will stay in stabilization mode before the iPCM12 becomes out of service (see Out Of Service (page 5-112)). Values: 0 to 65000
Purge in Stabilisation State	Tick this option to instigate the Purge flow when the stabilization state is entered.

Barriers

Select Set-Up|Barriers to customize the Barriers (if enabled):



Description of options:

Field Name	Description
Enable Left Barrier	Tick this option to enable the Left Barrier – see below for Barrier settings.
Enable Right Barrier	Tick this option to enable the Rear Barrier – see below for settings.
Ingress Closed During RCC	*This option is grayed out unless the Enable Front and/or Rear Barrier options are ticked.* Tick this option to prevent entry into the iPCM12 while the Residual Contamination Count is performed (see Residual Contamination Check (page 5-108)).
Ingress Closed During Out-Of-Service	*This option is grayed out unless the Enable Front and/or Rear Barrier options are ticked.* Tick this option to prevent entry into the iPCM12 while the unit is Out of Service (see Out Of Service (page 5-112)).
Ingress Closed When Ready	*This option is grayed out unless the Enable Front and/or Rear Barrier options are ticked.* Tick this option to prevent entry into the iPCM12 while the unit is Ready (see Normal Background Monitoring (page 5-91)).
NOTE: *The Barrier Settings only display when logged in as ThermoFisher (see Menu Roles (page 5-7). The Barrier Settings display if the Enable Left and/or Right Barrier option is ticked.*	
Entry Side	Set either Left or Right as the Entry side for the iPCM12.
Entry Settings – Left and Right	

Field Name	Description
Mode	Use the pre-defined window to select the type of Barrier that can be attached to the unit: · PCF Disabled · Doors · Barrier · Un-powered Doors · Turnstile – Normally Locked · Turnstile – Normally Unlocked
Transit time (x 100ms)	This is the time that is allowed for the worker to pass through the barrier. Values: 0 to 65535 seconds
High Current Limit (mA)	*This field is only enabled when Right Barrier Setting is selected.* The barrier will stall (see Evaluate Limits below for more explanation) above this High Current Limit. Values: 0 to 65535 milliamps
Low Current Limit (mA)	*This field is only enabled when Right Barrier Setting is selected.* The barrier will stall (see Evaluate Limits below for more explanation) below this Low Current Limit. Values: 0 to 65535 milliamps
Evaluate Limits	*This button is grayed out unless Barrier Mode is selected.* Select this button to commence a test sequence for the Barrier Mode, which will check the operation of the Barrier and detect the Low and High Current Limits. IMPORTANT – This button activates the Barrier to open and close. The **actual** values for the Low and High Current Limits insert into these fields. However, it is strongly advised that the Current Limit fields are set to the following values: Low Current Limit = between 0 and 10 High Current Limit = 1.5 x **actual** High Current Limit This will prevent the stall detection operating on the Barrier during normal usage.

Messages

It is possible to amend the Headline(s) and Instructions for the following messages:

- Normal Alarm
- High Level Alarm
- Radon Alarm
- Clear

Select Set-Up|Messages to select a message to configure:

Use the direction arrow to find a Message to configure. Once selected, update the text by pressing on the Headline, Headline 2, and Instruction fields. To save the changes, press the Apply Settings button.

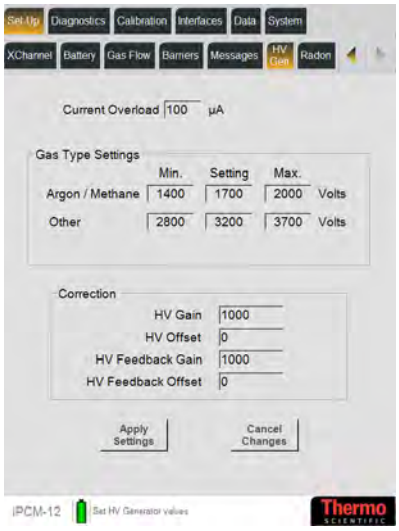
To set the selected message back to its default setting, press the Set Default button.

Available Messages:

Message	Headlines and Instructions
Normal Alarm	Contaminated – Please Contact HP
High Level Alarm	High Level – Please Contact HP
Radon Alarm	Probable Radon – Please Contact HP
Clear	Clear – OK to Leave Portal

HV Gen

Select Set-Up|HV Gen to set HV Generator values:



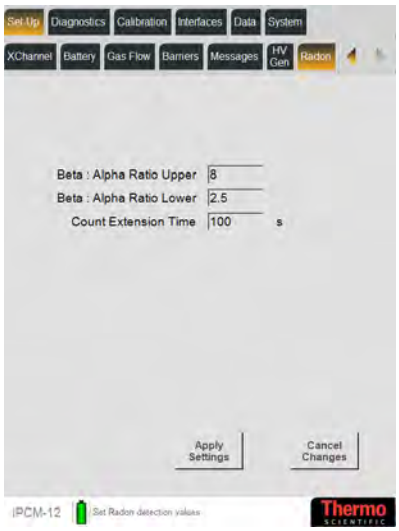
More information can be found at Performing the HV Scan (page 9-4).

For further information on setting up HV Generator values, contact Thermo Fisher Scientific.

Radon

When a contaminated result is produced from the gas flow detectors, a check will be made on the alarming detectors for evidence of Radon/Thoron presence. If indicated, then a message displays along with the alarm data indicating that Radon/Thoron may be present.

Select Set-Up|Radon to set Radon detection values:



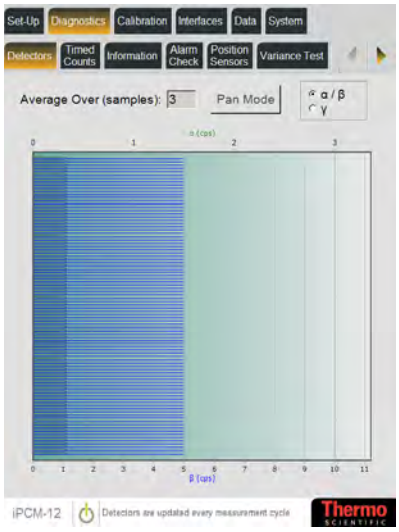
Description of options:

Field Name	Description
Beta : Alpha Ratio Upper	See Radon Rejection (page 6-9) for more information regarding the setting of these values.
Beta : Alpha Ratio Lower	
Count Extension Time (s)	

Diagnostics Menu

Detectors

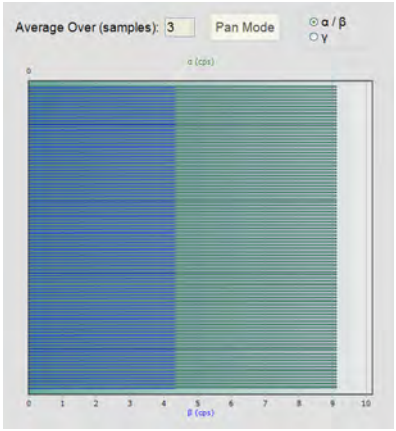
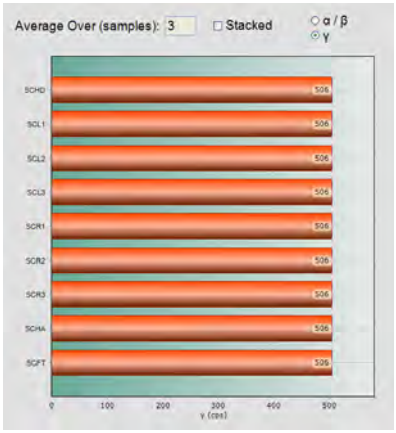
Select Diagnostics|Detectors to view
the Detectors' information:



The Detectors are updated every measurement cycle.

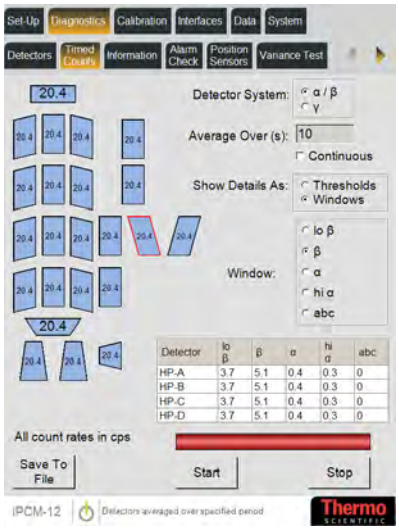
NOTE: The Background Count Rate is averaged and updated over the cycle time selected in the Average Over field.

Description of options:

Field Name	Description
Average Over (samples)	Enter the number of samples from which to calculate the average for display.
α/β or γ	If α/β is selected, the graph displays in Pan Mode:  If γ is selected, the graph displays as follows:  If the Stacked option is ticked, the graph displays as follows:

Timed Counts

Select Diagnostics|Timed Counts to view Detectors averaged over a selected specified period. This function allows a count to be made that can be used to ascertain the efficiency and functionality of the iPCM12.



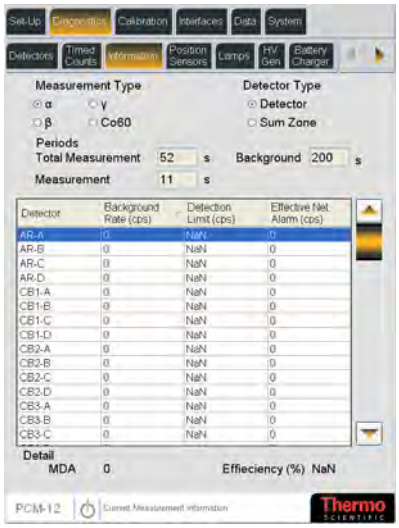
To Start the Timed Counts for the Detectors:

1. Select the Detector System – Alpha/Beta or Gamma.
2. Select the number of counts to be averaged by selecting a value in the Average Over field. If you require a Continuous count to be made, tick the Continuous box.
3. Toggle between the Thresholds and Windows display by clicking on the relevant radio button. Select from the options displayed.
4. Select a Window type from the list displayed.
5. Press Start button.

The counts can be halted at any time by pressing the Stop button. The results can also be saved by pressing the Save to File button and then selecting a directory and file name to save.

Information

Select Diagnostics|Information to view the current Measurement Information.

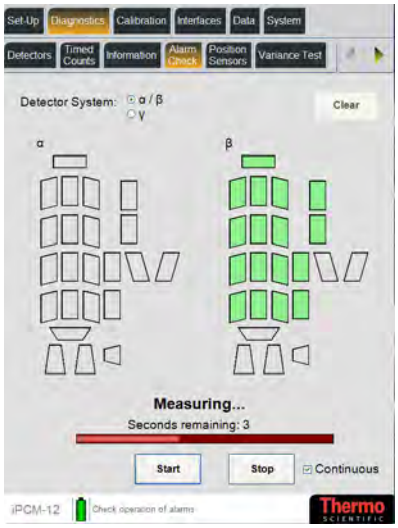


Description of options:

Field Name	Description
Measurement Type	Click on one of the radio buttons to select one of the following: · α– displays the Alpha count for the select Detector Group (see below). · β – displays the Beta count for the select Detector Group (see below). · γ – displays the Gamma count for the select Detector Group (see below). · Co60 – displays the Cobalt 60 count for the select Detector Group (see below).
Detector Type	Click on one of the radio buttons to select one of the following: · Detector – displays the counts for each individual detector · Sum Zone – displays the counts for all detectors
Total Measurement Period (s)	*This is a view only field.* This is the length of time for the sample to be calculated from the current alarm conditions and background measurement.
Alpha Measurement Period (s)	*This is a view only field.* This is the length of time for the alpha only sample to be calculated from the current alarm conditions and background measurement.
Background Period (s)	*This is a view only field.* This is the current background period. The value is set at 0 if a background has not yet been acquired.
Detector Information	*This is a view only field.* This is the Background Rate, Detection Limit, and Effective Net Alarm display for each Detector. For more information, see Description of Parameters Used in Calculations (page 6-10).
Detail	*This is a view only field.* The Minimum Detection Activity (MDA) and/or (depending on the Measurement Type selected above) the Efficiency percentage are displayed.

Alarm Check

Select Diagnostics|Alarm Check to check the operation of alarms.



To test the operation of alarms, select a Detector System from α / β or γ. At this point, if required, you can insert a source in the monitor. Press the Start Button. The Seconds Remaining will count down until an alarm is detected or the Quick Scan is triggered (see Operation (page 5-11)) or until the Maximum Monitoring Time has passed (see Monitoring (page 5-14)).

Tick the Continuous box for the Alarm Check to run constantly. Click the Stop button to halt the continuous mode.

Position Sensors

The instrument will have seven sensors for detecting the user's position in the portal as follows:

- Body (note that this sensor can be disabled – see Setup | Operation (page 5-11))
- Side of Leg
- Hand
- Left Sole
- Right Sole
- Left Top of Foot
- Right Top of Foot (note that this sensor can be disabled – see Setup | Operation (page 5-11))

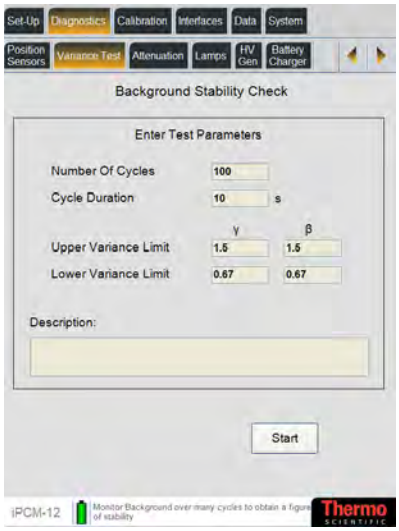
Select Diagnostics|Position Sensors to check the sensors and visual elements.

The green arrows in the diagram indicate the Position Sensors on the portal. These will detect when the user is correctly positioned prior to a measurement being taken (see Positioning (page 5-97) for more information.)

Variance Test

The variance check is a method by which the overall stability of the background can be assessed by running a sequence of background measurements and then assessing the variance of the measured backgrounds over the sequence.

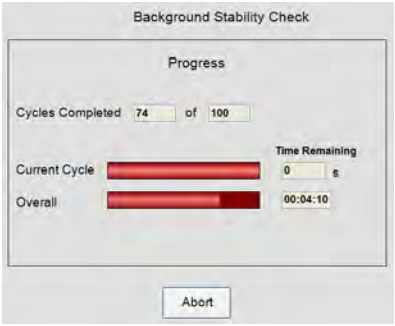
Select Diagnostics|Variance Test to setup the background monitoring over a number of cycles to obtain a figure of stability.



Description of options:

Field Name	Description
Number of Cycles	Enter the number of background measurements to be used in the test.
Cycle Duration (seconds)	Enter the duration of each measurement.
Upper Variance Limit	Enter the Upper Variance Limit for the result. Note that this value should initially be set to 1.5.
Lower Variance Limit	Enter the Lower Variance Limit for the result. Note that this value should initially be set to 0.67.
Description	Enter a description of the test.

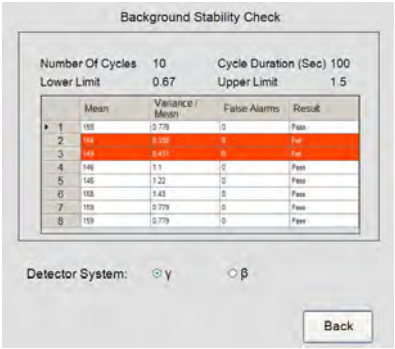
Once the options have been set, press Start to run the Background Stability Check. A progress window displays:



Press the Abort button to abandon the check. If the check completes, the results display as follows:

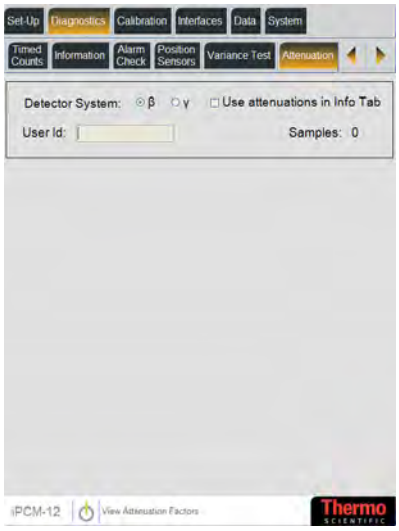
Select one of the Detector Group options to highlight the results for the relevant group.

Press Back button to return to the Test Parameters window.



Attenuation

Select Diagnostics|Attenuation to view
a worker's attenuation details:



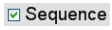
Description of options:

Field Name	Description
Detector System	Select a Radiation Type. Options: β γ
Use attenuations in Info Tab	Tick this box to use the data in the Information tab to be used (see Information (page 5-29).
User Id	Enter a User Id to view this worker's attenuation details.
Samples:	This is a view only field displaying the number of samples from which the details have been taken.

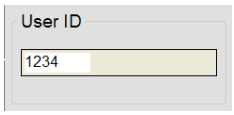
Lamps

Select Diagnostics|Lamps to check the visual elements.

Select the Sequence tickbox to test the Detector, LED, and Lamps display.

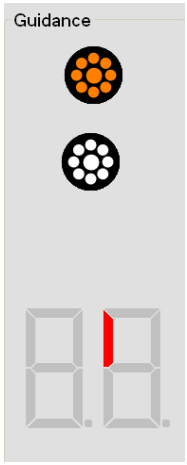


To test User ID, select the User ID input box and enter an ID, as follows:

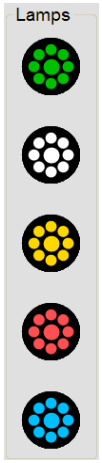


To test the Guidance and LED, tick the Sequence tickbox. Each segment of the LED will turn red sequentially.

The Detectors and Lamps will also light up sequentially.



To test the Lamps, press the lamp icon, which will light up.



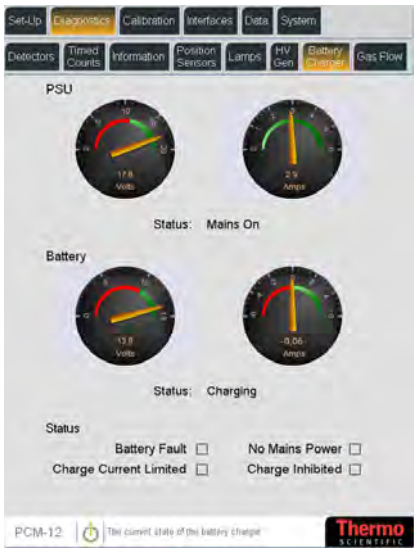
HV Gen

Select Diagnostics|HV Gen to check the current state of the HV Generator:

The Status options give an indication if there is an error with the HV Generator.

Battery Charger

Select Diagnostics|Battery Charger to view the current status of the battery charger:



The Status options give an indication if there is an error with the Battery Charger.

When the mains power is ON, the system charges the battery.

When no mains power is present, the system operates from the battery.

Barriers

NOTE: The Barriers have to be enabled in Set-Up|Barriers (page 5-23).

Select Diagnostics|Barriers to check the installed barriers:

To test the opening/closing of the barriers, tick the Open/Close buttons. The display will indicate with a green box if the barrier has opened/closed or is in Transit or whether the barrier is blocked or faulty, as follows:

To test the Activations, press the Emergency, Panic, or Entry Request buttons.

Gas Flow

This is a view only table.

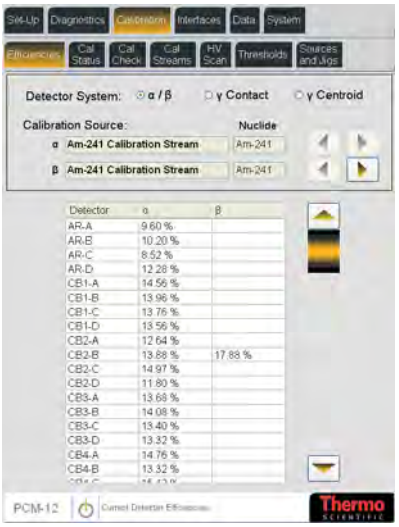
Select Diagnostics|Gas Flow to view the current status of the Gas Flow Controller:

Status	The Status options indicate whether there is an error with the Gas Flow.
Mode	The Mode option indicates whether the Gas Flow is in Normal or Purge Mode.
Resume Stabilization on exit from Admin Mode	This is ticked if the Stabilization was interrupted by access to the Administration Mode.

Calibration Menu

Efficiencies

Select Calibration|Efficiencies to view the Current Detector efficiencies:

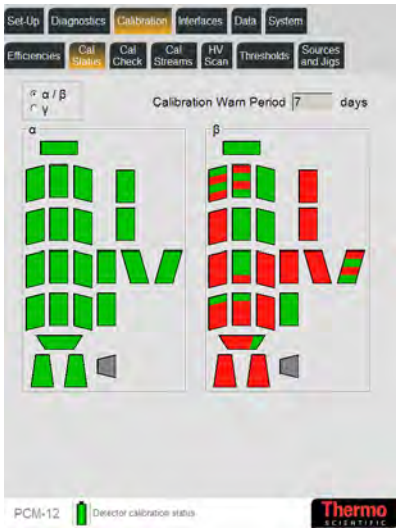


Select a Radiation Type from α / β, γ Contact or γ Centroid.

Once a Radiation Type is selected, it is possible to select a Calibration Source.

Cal Status

Select Calibration|Cal Status to view the Detector calibration status:



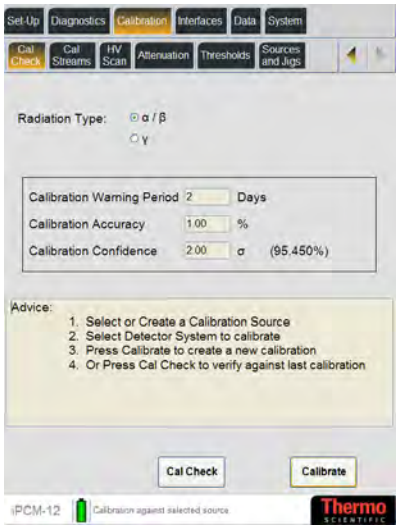
Select a Radiation Type from α / β or γ. The Calibration status of the Detectors displays.

- Disabled
- Out of Calibration
- Calibration Due
- In Calibration

Calibration Warn Period (days) This is a copy of the Calibration Warn Period field in Calibration (page 5-16).

Cal Check This option allows the user to edit existing Calibration sources and create new ones. There are also functions available to allow the user to check or overwrite the current calibration factor.

Select Calibration|Cal Check to edit the Calibration setting against a selected source and to conduct a calibration check.



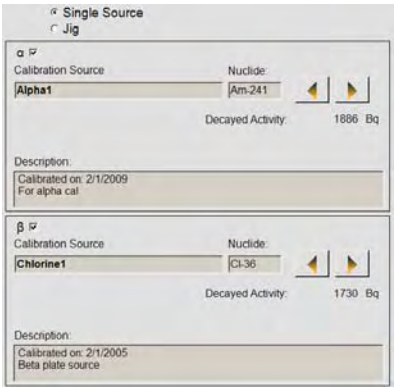
NOTE: The Calibrate button is not available to the Technician role.

Description of options:

Field Name	Description
Calibration Warning Period (days)	*This is a view only field.* The number of days since that last calibration date. This is a copy of the Calibration Warn Period field in Calibration (page 5-16). See Out of Calibration (page 5-88) to view the message displayed on the unit when out of date.
Calibration Accuracy (%)	*This is a view only field.* A copy of the Default Calibration Accuracy field in Calibration (page 5-16).
Calibration Confidence (σ)	*This is a view only field.* A copy of the Calibration Confidence field in Calibration (page 5-16).

All calibration results are logged to the database. The "Calibrate" function allows users to overwrite the Calibration factor. The "Cal Check" function informs the user of any discrepancy with the current calibration factor.

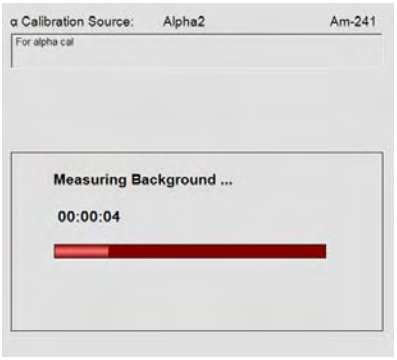
To Calibrate or Cal Check against α / β, select a Radiation Type = α / β and then press the Calibrate or Cal Check button. The following Calibration Single Source window displays.



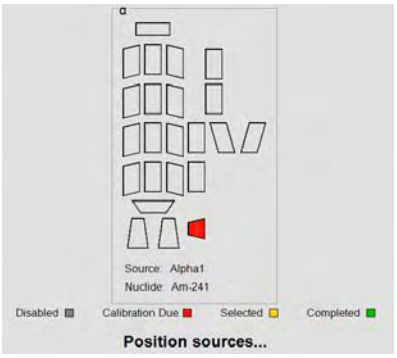
See Sources and Fixtures (page 5-55) for more information regarding the setting up of Sources and Fixtures.

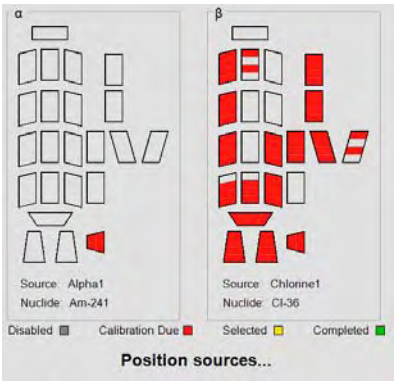
Select the Fixture radio button to display the multiple Sources as follows:

Use the direction arrows to select a Calibration Source. Once selected, press the Next button to start the Measurement of the Background:

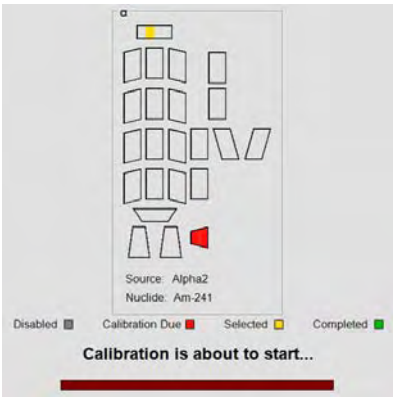


Once the background has been measured, position the sources:

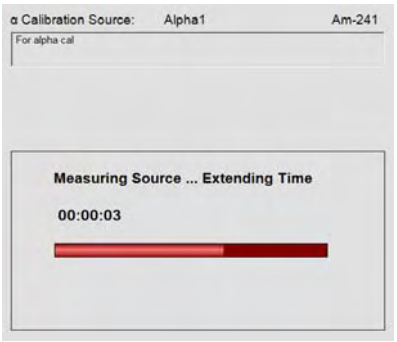




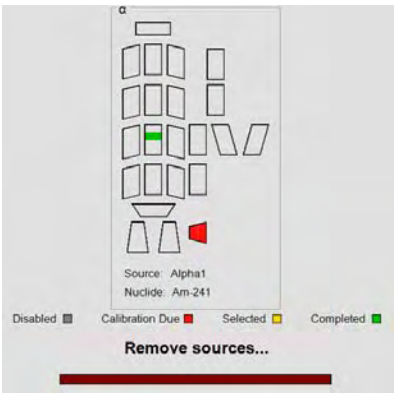
Once the iPCM detects the sources, the Calibration is about to start a message displays. The display indicates where the source has been selected in yellow:



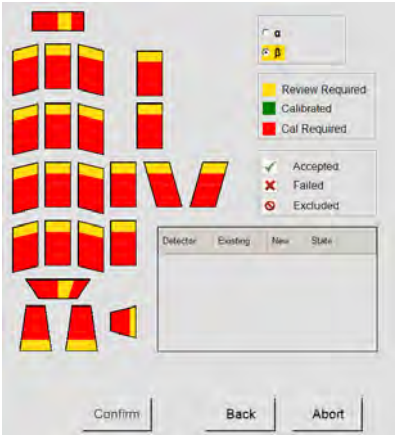
The source is now measured:



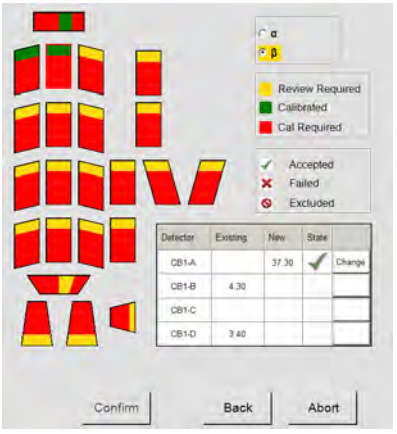
The display indicates which area has been completed in green:



This process can be repeated as required. When completed, select the Done button to see a review of the process.

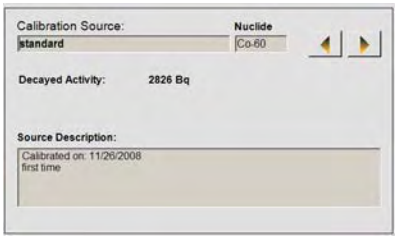


Click on a detector to see the new calibration details.



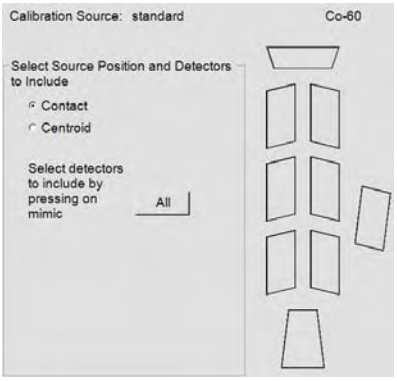
When all the detectors have been accepted, press the Confirm button to display the Calibration Source description page:

To Calibrate or Cal Check against γ, select a Radiation Type = γ and then press the Calibrate or Cal Check button. The following Calibration Single Source window displays.



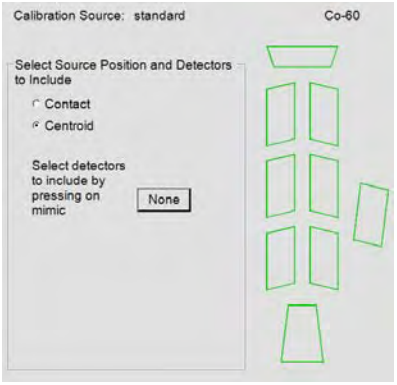
See Sources and Fixtures (page 5-55) for more information regarding the setting up of Sources and Fixtures.

Use the direction arrows to select a Calibration Source. Once selected, press the Next button to view the Select Source Position and Detectors window:

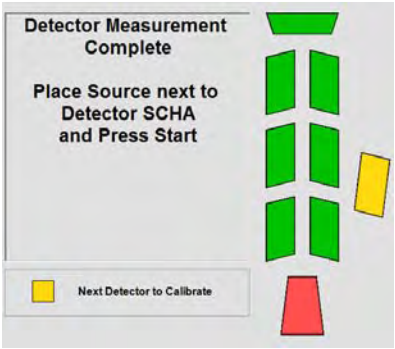


Select Contact or Centroid Source Position and then select All or None of the detectors to be included.

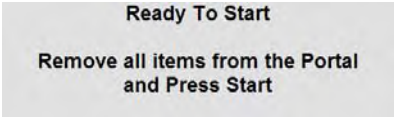
If All is selected, the Detectors are highlighted in green:



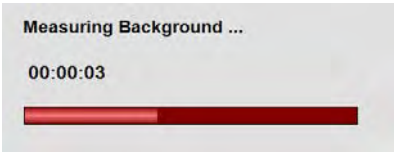
If None is selected, the iPCM12 will instruct where the source is to be placed as follows:



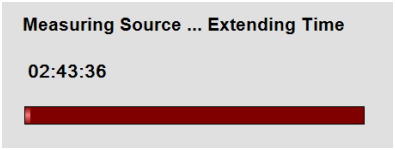
Press the Start button to continue:



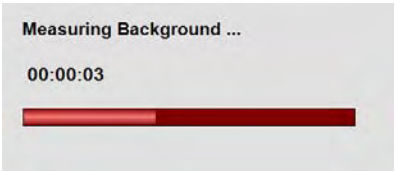
Press the Start button to commence the background measurement:



Once the Background Measurement has been completed, place the Source as instructed and press Start:

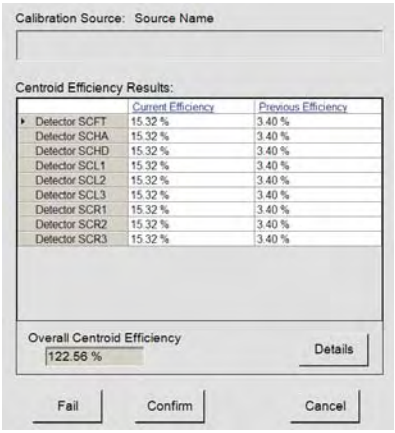


Once the Source Measurement has been completed, remove the Source as instructed and press Start:



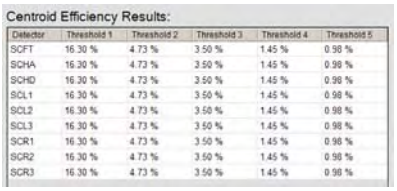
Once the second Background Measurement has been completed, the Results display:

During a Cal Check only an OK button displays, which returns to the Calibration|Cal Check screen.



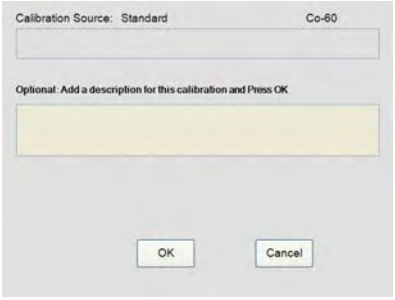
If the calculated efficiency has an illegal value (i.e., no net counts), the efficiency will be set to zero.

Select Details button to view details results:



If you are satisfied with the result, press the Confirm button to display the Add Description for the Calibration page. Select OK to complete the process.

The results are stored in the database and marked as PASS.



If you are NOT satisfied with the result, press the Fail button. The Calibration Source page is re-displayed.

NOTE: The results are stored in the database and marked as FAIL.

Description of Error messages:

Error Message	Resolution
Unable to calculate a valid monitoring time	1. There is no source available. 2. The source does not have enough activity. 3. If a cobalt calibration has been activated and the source is not Co60.
This is not the default Calibration Source	This is a warning message only.

Cal Streams

Select Calibration|Cal Streams to view current Calibration and create new customized Calibrations.

NOTE: The Active Calibration displays in the top box.

To change the Active Calibration, use the direction arrows to select a Calibration. Once selected, press the Make Active button. The selected Calibration will display in the top box.

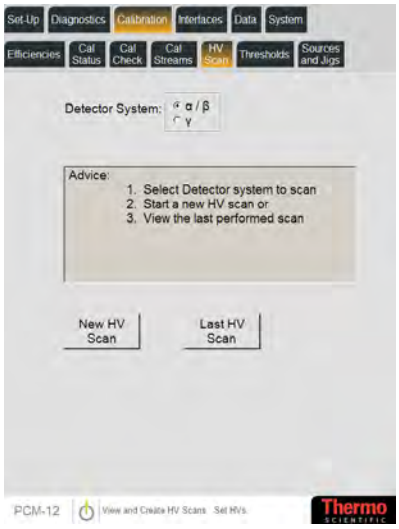
To edit a Calibration Mix, select a Calibration. Press in the Calibration field to edit the Calibration name. In the Calibration Mix section, use the drop-down list to change the Nuclide. Press in the Percentage field to edit the percentage. When complete, press the Apply Settings button to save or the Cancel button to quit without saving.

To create a new Calibration Mix, highlight in an empty Calibration Mix window (or an existing Calibration Mix to overwrite) and click on the Create New Mix button. Press in the Calibration field to create a new Calibration name. In the Calibration Mix section, use the drop-down list to add a new Nuclide. Press in the Percentage field to edit the percentage. When complete, press the Apply Settings button to save or the Cancel button to quit without saving.

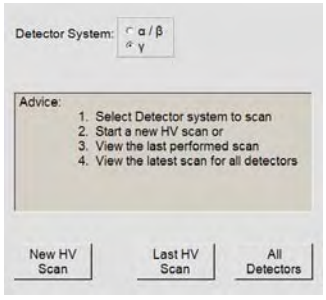
To delete an existing Calibration Mix, highlight the Calibration Mix for deletion and press the Delete Mix button.

HV Scan

Select Calibration|HV Scan to view and create HV Scans. It is also possible to set HVs for detector amplifiers. The scan allows repeated counts at an increasing or decreasing HV to be recorded to ascertain detector operating point and efficiency.

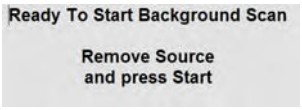


If Detector System γ is selected, the following window displays:



To start a new HV Scan, press the New HV Scan button to display the Please enter scan parameters window:

Press the Start button to display the Remove Source instruction window:



Ensure that there is no source near the iPCM12 and press Start.

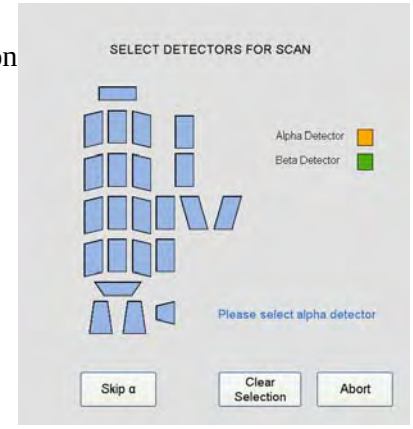
Description of options:

Field Name	Description
Minimum Voltage (V)	Enter a minimum voltage.
Maximum Voltage (V)	Enter a maximum voltage. *This value should be at least Minimum Voltage + Step Size.*
Step Size (V)	Enter a step size for the scan.
Step Duration (s)	Enter the length (in seconds) for each step.

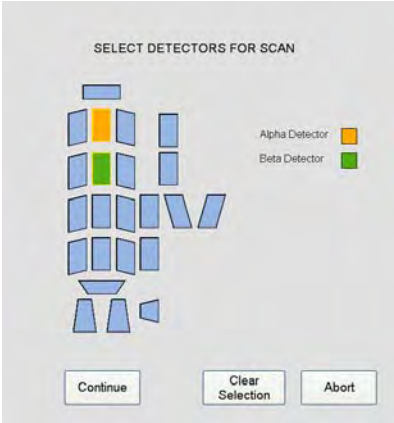
Once the above scan parameters have been established, two scans will be made against each amplifier threshold for all amplifiers at each HV step over the specified integration period:

- A background HV Scan
- A source HV Scan

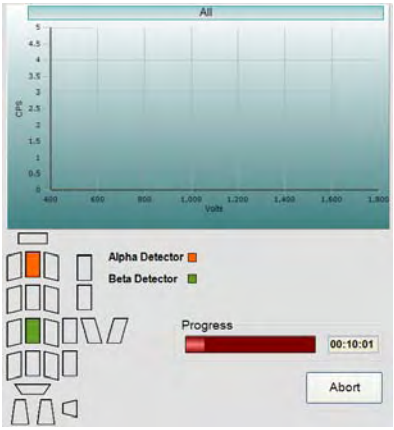
If Detector System α / β is selected, pressing the Start button will display the Select Detectors for Scan window:



Select an alpha detector and then a beta detector (you can skip selecting a second detector by pressing the Skip α or β button). Select the Continue button to start the HV Scan:

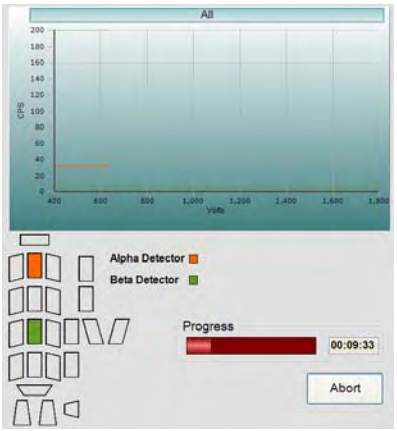


The background scan begins.

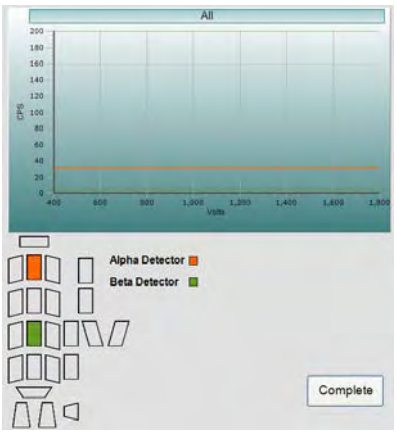


Once the Background Scan is complete, the Ready to Start Source Scan screen displays. Position the Source to be scanned in the iPCM12 and press the Start button. A source HV scan will be performed, recording the counts against **each amplifier threshold** for all amplifiers at each HV step over the specified integration period. A progress window displays:

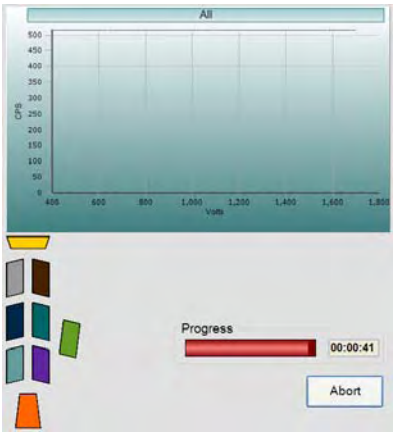
The source scan begins.



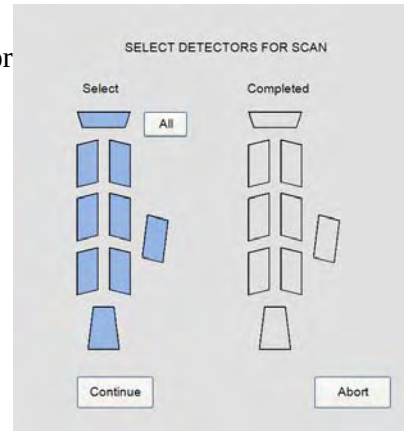
Once complete, the result displays. Select the Complete button to display the Scan Description window.



If Detector System γ is selected, the background scan starts immediately:



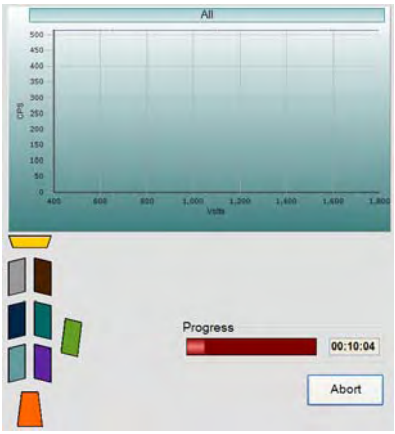
Once the background scan is complete, the Select Detectors for Scan window displays:



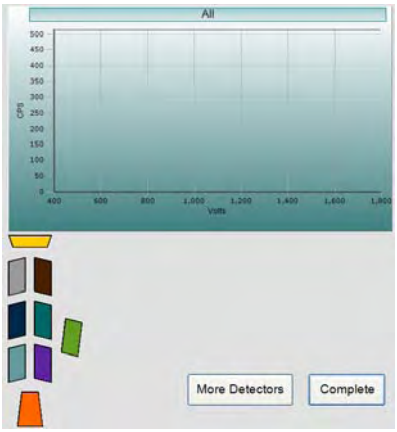
Select the All button or select individual detectors and then press the Continue button.

When the Ready to Start Source Scan window displays, position the source to be scanned in the iPCM12 and press the Start button. A source HV scan will be performed, recording the counts against **each amplifier threshold** for all amplifiers at each HV step over the specified integration period. A progress window displays:

The source scan begins.



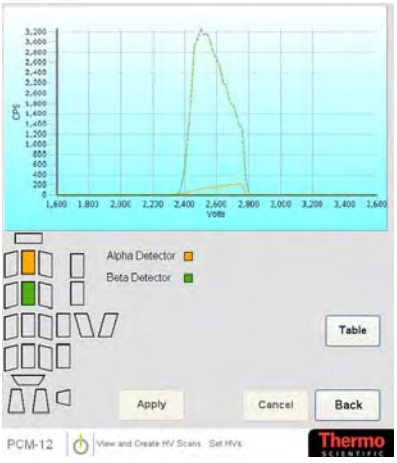
Once complete, the result displays. Select the Complete button to display the Scan Description window. Select the More Detectors button to scan more detectors.



Once the Scan is complete (and the Complete button has been pressed), a Save Scan window appears giving the option to save the scan or Abort the process.

To Save the Scan, press Save to display the Please enter a scan description window:

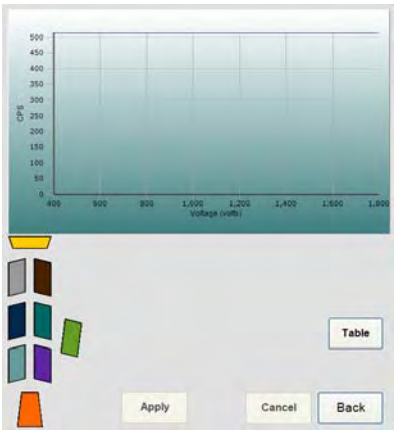
Enter a Scan Description and press the Save button to display the Scan results:



Select the Apply button to save the Scan.

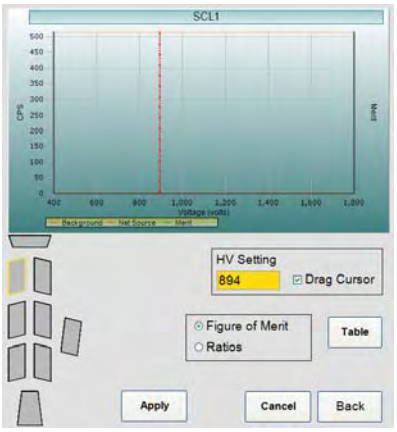
Press the Cancel button to quit without saving or press the Back button to return to the Start new scan screen.

If Detector System γ is selected and the All Detectors button is pressed, the user is able to setup the individual detectors.

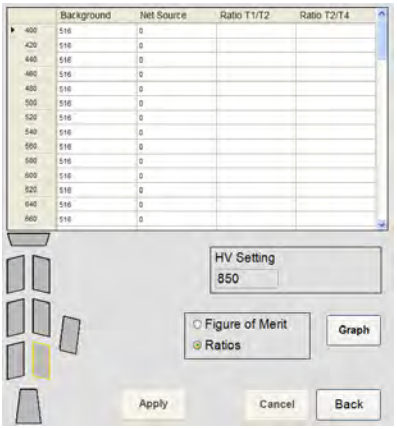


Select a detector to select its individual settings:

Tick the Drag Cursor box to enable the HV Setting by either dragging the cursor to the required value or setting the required value directly into the box. This enables the Apply button.



Select the Table button to view the HV Settings as chart values.



To view the HV Scan as a Table, press the Table button to display the scan results.

To view the HV Scan as a Graph, press the Graph button to display the scan results.

To view the current Scan for all detectors, press the Current HV Scan button to display the scan results.

To view the last saved HV Scan, press the Last HV Scan button to display the scan results.

See Performing the HV Scan (page 9-4) for more information regarding the HV Scan.

Attenuation

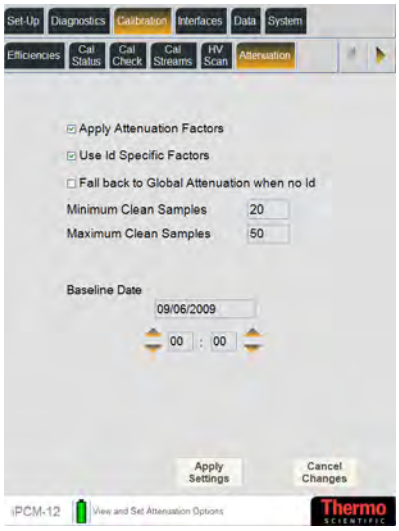
These are factors applied to measurements to compensate for background changes due to changes in background count rates caused by the insertion of a body into the portal.

As each user identifies him/herself to the instrument, the instrument will calculate a new background attenuation factor for all the beta and gamma detectors based on the mean counts attenuation for the last Minimum Clean Samples for the user.

If there are insufficient clean measurements, then the default attenuation factors will be used.

Select Calibration|Attenuation to view and set Attenuation Options:

This section is only used if User Id Required is selected in Setup|UI Options (page 5-9).



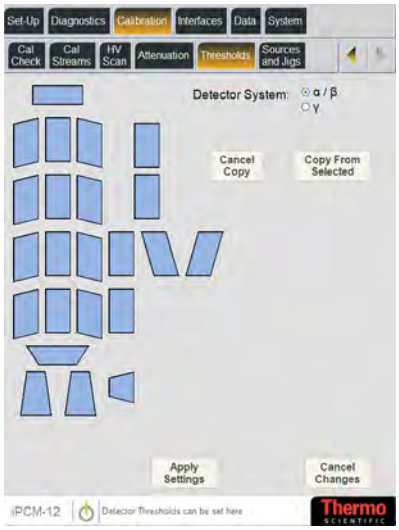
Description of options:

Field Name	Description
Apply Attenuation Factors	Tick this box to apply Attenuation Factors depending on the settings in this window.
Use Id Specific Factors	Tick this box to apply the factors depending on the user's Id.
Fall back to Global Attenuation when no Id	*This option displays if Use Id Specific Factors above is ticked.* Tick this option to apply global factors if the user's Id is not recognized (see also Attenuation (page 5-34)).
Minimum Clean Samples	This is the minimum number of clean samples required to apply the Attenuation Factors.
Maximum Clean Samples	This is the maximum number of clean samples required to apply the Attenuation Factors.

Field Name	Description
Baseline Date	This is the date from which the number of Attentuation Factors apply.

Thresholds

Select Calibration|Thresholds to set the Detector Thresholds:



This screen allows the individual voltage of any detector to be viewed and updated.

To change any of the settings, press on the detector field and update the value. Press the Apply Settings button to save or the Cancel Changes button to quit without saving.

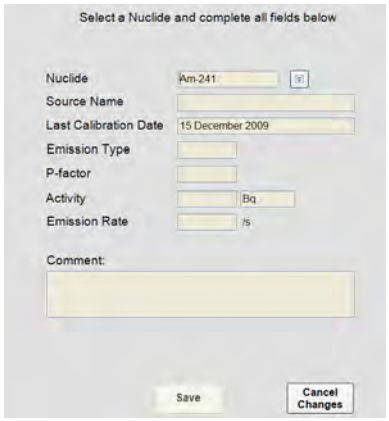
To copy from a selected Detector, highlight the detector to copy from and press the Copy From Selected button. Select the detector(s) to paste to and press the Paste to All Selected button.

NOTE: No threshold value should be set to a voltage that is less than that of the preceding threshold. For example, Threshold 5 must be set greater than or equal to Threshold 4. Failure to follow this advice may invalidate measurements. Please contact Thermo Fisher Scientific before changing threshold values.

Sources and Fixtures

Select Calibration|Sources and Fixtures to create the calibration sources and fixtures:

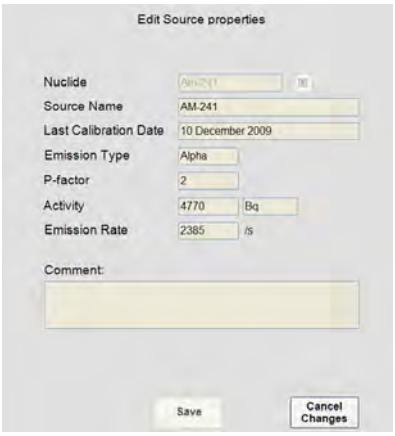
To create a new Calibration Source, press the New button. The Select a Nuclide window displays:



Description of options:

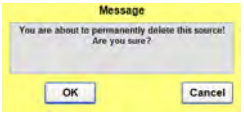
Field Name	Description
Nuclide	Select a Nuclide type from the drop-down box
Source Name	Enter a descriptive name (this is the name that displays in other fields).
Last Calibration Date	Select the last calibration date (the Save button is not enabled unless this date is in the past).
Emission Type	Select a type from the drop-down list (Gamma, Alpha or Beta).
P-factor	If left empty, this will cause the value to default to 1.
Activity	*The Activity is calculated as P-Factor * Emission Rate.* Enter an Activity value – **NOTE:** It is possible to alter the default Activity Units.
Emission Rate	*The Emission Rate is calculated as P-Factor * Activity.* Enter an Emission Rate.
Comment	Enter a comment if required.

To edit an existing Calibration Source, select a Calibration Source and press the Edit button. The Edit Source properties window displays:



See above for description of field names.

To delete an existing Calibration Source, select a Calibration Source and press the Delete button. The confirmation window displays:



To create a new Fixture, press the New button. The New Fixture window displays:

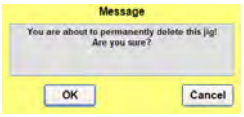
Description of options:

Field Name	Description
Name	Enter a name for the Fixture.
Source 1 / 2	Select a Source from the list (see above for description on how to create Source).
Nuclide	These fields are auto-entered according to the Source selected above.
Decayed Activity	
Emission Type	
Jig Description	Enter a descriptive name (this is the name that displays in other fields).

To edit an existing Fixture, select a Fixture and press the Edit button. The Edit Fixture properties window displays:

See above for description of field names.

To delete an existing Fixture, select a Fixture and press the Delete button. The confirmation window displays:



Interfaces

Plug-ins

Select Interfaces|Plug-ins to configure an interface to another system:

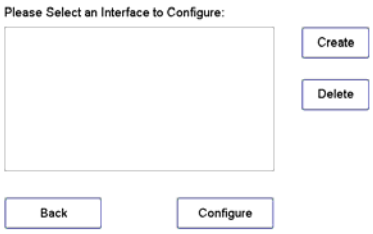
NOTE: Interfaces are not limited to the examples given below. Other interfaces are possible and the parameters described below may vary according to the interface selected. Please contact Thermo Fisher Scientific regarding your specific interface requirements.

- EPD Id Reader – see EPD Id Reader (page 50)
- IDS Camera – see IDS Camera (page 50)
- Keyboard Emulating Id Provider – see Keyboard Emulating Id Provider (page 51)
- Serial Barcode Reader – see Serial Barcode Reader (page 52)

For more information in setting up any of these Plug-ins, please contact Thermo Fisher Scientific.

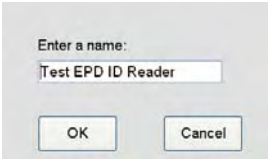
To Configure an Interface

Highlight the Interface to configure and select the Configure Interface button:



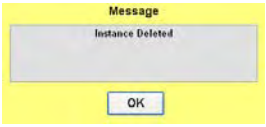
The selected type of interface displays in the top left hand corner.

The Create button allows the user to Create a new Interface.



The user is prompted to enter a name for the new Interface.

To delete an existing interface, highlight the Interface and press the Delete button. Select OK to continue.

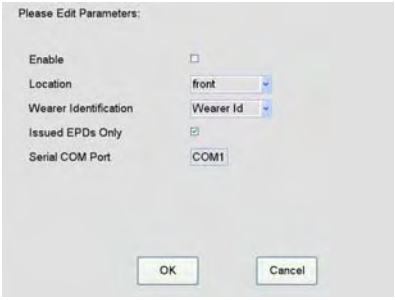


The Configure button allows the user to configure an existing highlighted interface.

The Back button returns the user to the previous screen.

EPD Id Reader

Press the OK button to display the editable parameters for the EPD Id Reader:

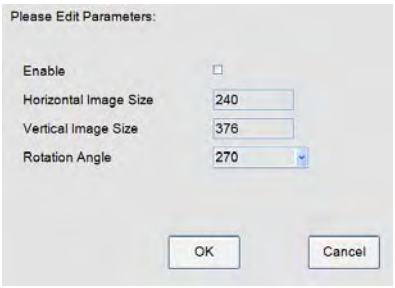


Description of options:

Field Name	Description
Enable	Tick this option to enable the interface to work with the iPCM12.
Location	Use the drop-down button to select either front, rear, or either.
Wearer Identification	Use the drop-down button to select either Wearer Id or Wearer Name as Wearer Identification.
Issued EPDs Only	Tick this box if the reader is to detect Issued EPDs only.
Serial COM Port	This is the COM Port for connection to the interface.

IDS Camera

Press the OK button to display the editable parameters for the IDS Camera:



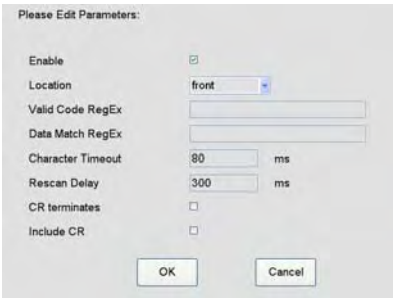
Description of options:

Field Name	Description
Enable	Tick this option to enable the interface to work with the iPCM12.
Horizontal Image Size	Enter the horizontal image size (in mm).
Vertical Image Size	Enter the vertical image size (in mm).
Rotation Angle	Use the drop-down button to select either 0, 90, 180 or 270.

Keyboard Emulating Id Provider

NOTE: A Keyboard Emulating Id Provider is the terminology used for a USB Barcode Reader.

Press the OK button. The editable parameters for the Keyboard Emulating Id Provider displays:



Description of options:

Field Name	Description
Enable	Tick this option to enable the interface to work with the PM12.
Location	Use the drop-down button to select either front or rear.
Valid Code RegEx Data Match RegEx	These fields permit validation of a barcode and extraction of portions of data within the barcode for the Stream ID. If left bank, no validation is performed and any barcode is valid. See Notes Regarding Regular Expressions for Barcode (below) for further information.
Character Timeout (ms)	The period during which the scanner can receive barcode data. If the barcode is not detected during this time, it resets. Default: 100 milliseconds

Field Name	Description
Rescan Delay (ms)	Once a barcode has been read, this is the period before a subsequent barcode can be read. Default: 500 milliseconds
CR terminates	If a Carriage Return is to indicate the end of the barcode, tick this box. Default: Ticked
Include CR	If a Carriage Return is to be included within the barcode, tick this box. Default: Unticked

Notes Regarding Regular Expressions for Barcode

Here are a few common regular expressions that may be used for any of the IDs above:

Start of line string	^
End of line string	$
Whitespace character	\s
Word character	\w
Digit character	\d

You can specify the type of characters as follows:

[0-9] numbers only

[a-z] any lowercase ASCII letters

[A-Z] any uppercase ASCII letters

[0-9A-Z] alpha-numerical (note the space following the A-Z)

{x,y} where x is the minimum number of characters and y is the maximum number of characters; e.g.,{4,10} would read a minimum of 4 up to a maximum of 10, {4} would read exactly 4 characters and {4,} would read a minimum of 4 with no maximum

Named capture group (?<*name*>…)

Examples:

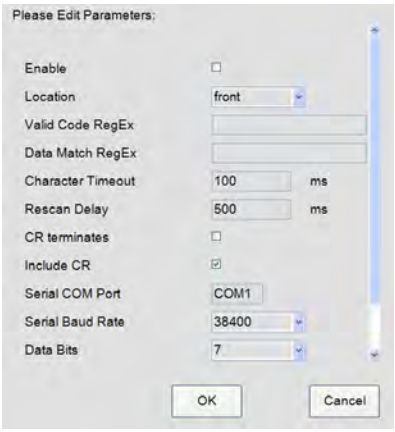
User ID	^U(?<id>[0-9A-Z]{4,})
Numbers from 0 to 999999	^\d{1,6}$ e.g. 123, 123456
US Social Security number	^\d{3}- \d{2}- \d{4}$ e.g. 123-12-1234

For more information on setting up valid barcode expressions, contact Thermo Fisher Scientific.

Serial Barcode Reader

Press the OK button. The editable parameters for the Serial Barcode Reader displays:

Use scroll bar to view last two parameters.



Description of options:

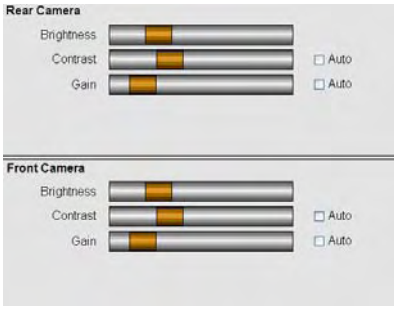
Field Name	Description
Enable	Tick this option to enable the interface to work with the iPM12.
Location	Use the drop-down button to select either front or rear.
Valid Code RegEx Data Match RegEx	These fields permit validation of a barcode and extraction of portions of data within the barcode for the Stream ID. If left bank, no validation is performed and any barcode is valid. See Notes Regarding Regular Expressions for Barcode (page 5-60) for further information.
Character Timeout (ms)	This is the period during which the scanner can receive barcode data. If the barcode is not detected during this time, it resets. Default: 100 milliseconds
Rescan Delay (ms)	Once a barcode has been read, this is the period before a subsequent barcode can be read. Default: 500 milliseconds
CR terminates	If a Carriage Return is to indicate the end of the barcode, tick this box. Default: Ticked
Include CR	If a Carriage Return is to be included within the barcode, tick this box. Default: Unticked
Serial COM Port	This is the COM Port for connection to the interface.
Serial Baud Rate	Use the pre-defined window to select Baud Rate from one of the following: 9600 19200 38400 115200 Default: 38400

Field Name	Description
Data Bits	Use the pre-defined window to select Data Bits from one of the following: 7 8 Default: 7
Parity	Use the pre-defined window to select Parity from one of the following: None Even odd Default: Even
Stop Bits	Use the pre-defined window to select Stop Bits from one of the following: 1 2 Default: 7

Camera

NOTE: This option is only available if camera(s) have been installed (see IDS Camera (page 5-59)).

The current image displays on screen.



To adjust the Brightness, move the orange bar to the left to decrease the brightness and to the right to increase the brightness.

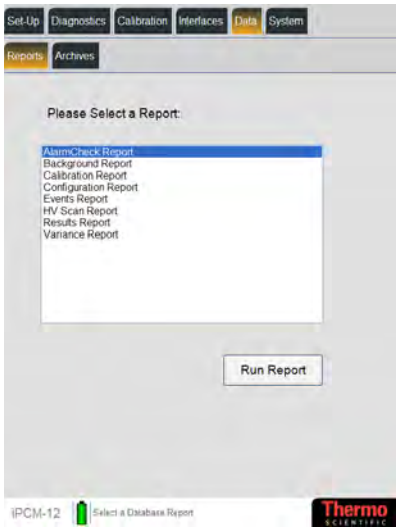
To adjust the Contrast, move the orange bar to the left to decrease the contrast and to the right to increase the contrast. Tick the Auto button for automatic adjustment of the contrast.

To adjust the Gain, move the orange bar to the left to decrease the gain and to the right to increase the gain. Tick the Auto button to control the gain of a signal automatically.

Data Menu

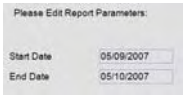
Reports

Select Data|Reports to select a Database Report from a pre-defined list:



To run a report, select one from the list and press the Run Report button. The types of Reports available are listed below.

Each report can be limited by various parameters.



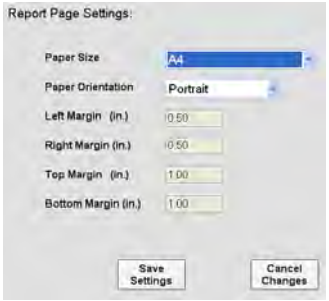
Each report displays the following button bar:

Report Button Functions

Direction Arrows steps through the report pages

Direction Arrows moves the report up and down

Page Setup displays the Report Page settings:



Enter the required settings and press OK.

Print — The Print button sends the report to the printer.

Save — The Save button displays the Drive selection window to allow you to select a Drive for the saved report. The report will be saved as an Excel spreadsheet with the following name:

<Report Type><YYMMDDHHMM>.xls

e.g.

ResultsReport0902261151.xls

Stop — Stop cancels the processing of the report.

Back — Back returns the user to the previous screen.

Alarm Check Report

This report shows the Alarm Check Summary information between the selected Start and End Dates. It is possible to limit the report by Start and End Date.

Alarm Check Summary

ID	Test Start Time	Source Name	Measurement Count
1	04/10/2007 11:35:31	Standard	21

Press on one of the ID records to display the Background Measurement Detail for the selected Measurement ID:

Background Variance Test Results Detail

Test Date: 04/10/2007 11:35:31

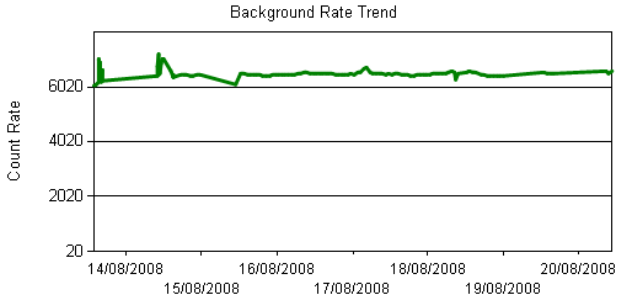
Detector	Normal Alarms	Normal Alarm Multiplier	High Alarms	High Alarm Multiplier	Cobalt Alarms	Cobalt Alarm Multiplier
1	2	2.32	0	0.00	0	0.00
2	2	2.48	0	0.00	0	0.00
3	2	2.38	0	0.00	0	0.00
4	2	2.31	0	0.00	0	0.00
5	2	1.93	0	0.00	0	0.00
6	2	2.45	0	0.00	0	0.00
7	2	2.23	0	0.00	0	0.00
8	2	2.24	0	0.00	0	0.00

Background Report

This report shows the Background Rate Trend between the selected Start and End Dates. It is possible to limit the report by Start and End Date, Radiation Type (Alpha, Beta or Gamma), and Statistic (Max, Min, Mean).

NOTE: The report below is an example and does not display all the information.

Background Measurement Summary



ID	Measurement Date	Count Rate	Changing	Integration Period
126	20/08/2008 10:29	6555	Yes	10
125	20/08/2008 09:23	6469	Yes	10
124	20/08/2008 08:41	6564	Yes	10
123	19/08/2008 16:02	6471	No	100
122	19/08/2008 15:05	6469	Yes	10
121	19/08/2008 13:56	6489	No	100
120	19/08/2008 12:56	6527	Yes	10
119	18/08/2008 23:54	6395	No	100

Press on one of the ID records to display the Background Measurement Detail for the selected Measurement ID:

NOTE: The report below is an example and does not display all the information.

Background Measurement Detail

Background ID: 126 Date/Time: 20/08/2008 10:29

Detector	Threshold	Count Rate (cps)	Integration Period
1	1	727	10
1	2	176	10
1	3	168	10
1	4	74	10
1	5	37	10
2	1	812	10
2	2	147	10
2	3	139	10
2	4	62	10
2	5	24	10
3	1	859	10
3	2	159	10
3	3	155	10
3	4	64	10
3	5	23	10
4	1	738	10
4	2	127	10
4	3	121	10
4	4	44	10
4	5	18	10
5	1	909	10
5	2	164	10
5	3	151	10
5	4	68	10
5	5	25	10
6	1	699	10
6	2	117	10
6	3	110	10
6	4	39	10
6	5	19	10
7	1	858	10
7	2	141	10
7	3	133	10
7	4	53	10
7	5	20	10
8	1	953	10
8	2	170	10
8	3	160	10
8	4	72	10
8	5	35	10

Calibration Report

This report lists Calibration History for the iPCM12. It is possible to limit the report by Start and End Date, and Full Cal.

Calibration History

ID	Calibration Date	Source Types	Pass / Fail	Comments
10	14/12/2009 15:12:55	Beta	Pass	
9	14/12/2009 15:09:43	Beta	Pass	
8	14/12/2009 15:07:48	Beta	Pass	
7	14/12/2009 14:56:37	Gamma	Pass	
6	14/12/2009 13:34:22	Gamma	Pass	
5	14/12/2009 11:49:47	Alpha	Pass	
4	14/12/2009 11:49:20	Alpha	Pass	
3	14/12/2009 11:48:49	Alpha	Pass	
2	14/12/2009 11:48:00	Alpha	Pass	Calib_1
1	14/12/2009 11:39:22	Gamma	Pass	

Press on one of the ID records to display the Calibration Efficiencies for the selected Calibration ID:

Calibration Efficiencies

Instrument: UKFER-2L3MN3J Location: Not Set

Calibration ID: 7 Calibration Date: 14/12/2009 14:56:37

Confidence: 2.00

Accuracy: 1.00 %

Source Name	Nuclide	Emission Type	Decayed Activity (Bq)
Co-60	Co-60	Gamma	2996

Detector		Threshold	Activity Efficiency (%)
SCL1	Contact		
		1	1557.27
		2	409.64
		3	208.00
		4	6.34
		5	0.00

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Configuration Report This report lists the current Instrument Configuration settings.

NOTE: The report below is an example and does not display all the information.

Configuration Settings on 14 December 2009

Instrument: UKFER-2L3MN3J

Configuration Item	Value
Alarm Requires Supervisor Acknowledge	No
Alpha Body POD (σ)	1.65
Alpha Body POFA (σ)	1.751
Alpha Detection Enabled	Yes
Alpha Foot POD (σ)	1.65
Alpha Foot POFA (σ)	1.751
Alpha Hand POD (σ)	1.65
Alpha Hand POFA (σ)	1.751
Alpha High Background Limit (cps)	100
Alpha Low Background Limit (cps)	0
AlphaMaxTimeBetweenCounts	200
AlphaRateOverFullBackground	No
Alpha Background Stability Ratio	10
Portal Approach Time (s)	2
AttenuationBaselineDate	06/09/2009 00:00:00
BetaHandPodKey	3.1
BetaHandPofa	1.65
BetaHandPofaKey	1.65
BetaHighBackgroundLimit	10000
BetaLowBackgroundLimit	0
BetaQuickScanEnabled	No
Cal Check Required Interval (days)	0
Default Calibration Accuracy (%)	0.5
Default Calibration Confidence (%)	3

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Configuration Item	Value
Gross Changing Background Sigma	5
Changing Conditions Sigma	4
Detector Changing Background Sigma	7
Changing Conditions Check Period	2
Co60 Alarms Enabled	No
Complete All Steps	Yes
Background Data Retention (months)	12
Calibration Check Data Retention (months)	3
Calibration Data Retention (months)	24
Event Log Data Retention (months)	6
Results Data Retention (months)	6
DefaultAlphaBetaCalCheckSourceType	0
DefaultAlphaCalibrationSource	
DefaultBetaCalibrationSource	
Default Calibration Source	
DefaultCalReviewTolerance	5
DefaultGammaCalibrationSource	
Probability of False Alarm	3.1
Probability of Detection	1.65
AttenuationLowerLimit	0.5
AttenuationUpperLimit	1.2
AutoRecount	No
Background Monitoring Period (s)	100
Background Logging Interval (hours)	0
Beta Body POD (σ)	1.65
Beta Body POFA (σ)	1.751
Beta Detection Enabled	Yes
Beta Foot POD (σ)	1.65
Beta Foot POFA (σ)	1.751
Beta Hand POD (σ)	1.65
Beta Hand POFA (σ)	1.751
Beta High Background Limit (cps)	10000
Beta Low Background Limit (cps)	1
Beta Quickscan Enabled	Yes
BetaRateOverFullBackground	No
Beta Background Stability Ratio	2
Cal Check Required Interval (days)	0
Default Calibration Accuracy (%)	1
Default Calibration Confidence (%)	2

Beta Foot POD (σ)	1.65
Beta Foot POFA (σ)	1.751
Beta Hand POD (σ)	1.65
Beta Hand POFA (σ)	1.751
Beta High Background Limit (cps)	10000
Beta Low Background Limit (cps)	1
Beta Quickscan Enabled	Yes
BetaRateOverFullBackground	No
Beta Background Stability Ratio	2
Cal Check Required Interval (days)	0
Default Calibration Accuracy (%)	1
Default Calibration Confidence (%)	2
CalWarnTime	2
Camera Fitted	Yes
Gross Changing Background Sigma	5
Changing Conditions Sigma	4
Detector Changing Background Sigma	7
Changing Conditions Check Period (s)	2
CleanOnRAdonOnlyKey	No

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Events Report

This report lists the Event History details between the selected Start and End dates. It is possible to limit the report by Start and End Date, and Changing Background.

NOTE: The report below is an example and does not display all the information.

Event History

Instrument: UKFER-2L3MN3J Location: Not Set

Event Time	#	Description	Additional Info	Category
14/12/2009 15:07:48	3	New Calibration Saved		Info
14/12/2009 15:02:07		Recovered From Out Of Service		Info
14/12/2009 15:02:00		Out of Service (Recoverable)		Info
14/12/2009 15:02:00		High α Background Rate : TF-B		Info
14/12/2009 13:36:08	2	Instrument Parameters Changed		Info
14/12/2009 13:34:22		New Calibration Saved	Cal Source Id: 3 -	Info
14/12/2009 11:48:49	3	New Calibration Saved		Info
14/12/2009 11:48:00		New Calibration Saved	Calib_1	Info
14/12/2009 09:06:48	4	Instrument Parameters Changed		Info
14/12/2009 08:38:32	4	Amplifier HV levels changed		Info

14/12/2009 08:32:42		Instrument Starting Up		Info
11/12/2009 10:06:00		Edited Source Details: Co-60		Info
11/12/2009 10:04:34		Edited Source Details: AM-241		Info
10/12/2009 14:02:50	2	Instrument Starting Up		Info
10/12/2009 09:59:44		Active Calibration Changed: UNCAL - Alpha Stream		Info
10/12/2009 09:31:46	2	Instrument Parameters Changed		Info
10/12/2009 08:57:23		Recovered From Out Of Service		Info
10/12/2009 08:57:14		Out of Service (Recoverable)		Info
10/12/2009 08:57:14		High α Background Rate : TH-A		Info
10/12/2009 08:56:47		Instrument Starting Up		Info
09/12/2009 16:02:41		Program Exit		Info
09/12/2009 14:33:09	10	Instrument Parameters Changed		Info
09/12/2009 14:32:50		Recovered From Out Of Service		Info
09/12/2009 14:32:43		Out of Service (Recoverable)		Info
09/12/2009 14:32:43		Low β Background Rate: TH-A	TH-A	Info
09/12/2009 14:31:20		Background Stable		Info
09/12/2009 14:30:41		XChannel Node Changed		Info
09/12/2009 14:26:46		Background Stable		Info
09/12/2009 14:26:33		Instrument Starting Up		Info
09/12/2009 14:22:24		Background Stable		Info
09/12/2009 14:14:50	2	Instrument Starting Up		Info
09/12/2009 14:10:40		Alarm Thresholds Changed		Info
09/12/2009 14:10:20		Instrument Parameters Changed		Info
09/12/2009 14:10:03		Default Calibration has no Alarms Configured		Error
09/12/2009 14:09:28		XChannel Node Changed		Info
09/12/2009 14:07:26		Default Calibration has no Alarms Configured		Error
09/12/2009 14:07:20		Instrument Starting Up		Info
09/12/2009 14:06:08		Default Calibration has no Alarms Configured		Error
09/12/2009 14:06:01		Instrument Starting Up		Info
09/12/2009 14:04:42		Unable To Open XChannel Interface		Error
09/12/2009 12:54:54	3	Instrument Starting Up		Info
09/12/2009 12:49:54		Unable To Open XChannel Interface		Error
09/12/2009 12:49:53		Unable To Open XChannel Interface		Error
09/12/2009 12:49:45		Instrument Starting Up		Info

HV Scan Report

This report lists the HV Scan details between the selected Start and End dates. It is possible to limit the report by Start and End Date.

HV Scan List

ID	Scan Date	System system	Start HV	End HV	Step HV	Step Period (s)	Description
3	10/12/2009 10:17:03	Alpha / Beta	400	1800	20	10	Test 2
2	10/12/2009 10:13:07	Gamma	400	1800	20	10	Test1
1	10/12/2009 10:09:08	Alpha / Beta	600	2800	20	10	

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Press on one of the ID records to display the HV Scan Detail for the selected Scan ID:

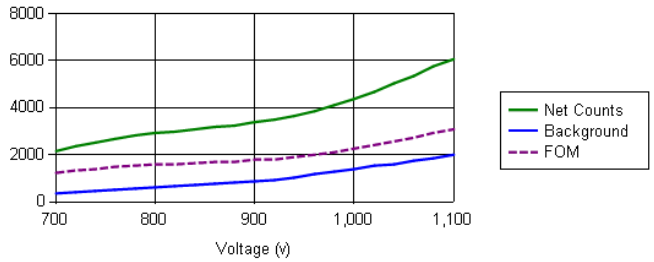
NOTE: The report below is an example and does not display all the information.

HV Scan Detail

Scan ID: 2 **Scan Date:** 13/08/2008 12:32:07

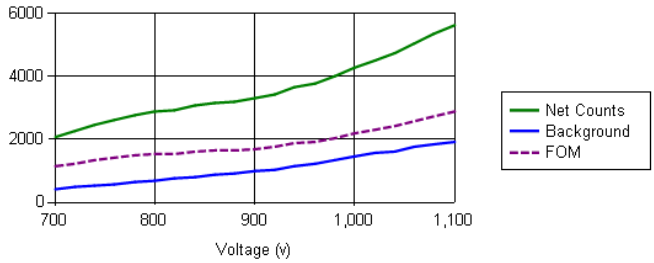
test2

Detector: 2



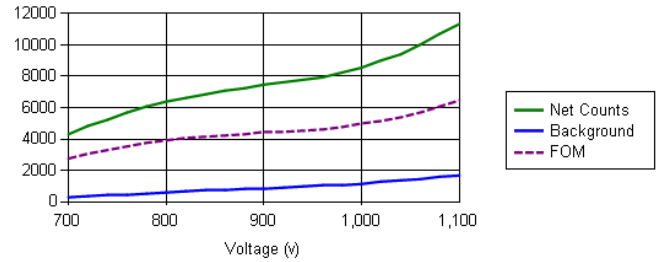
Voltage	Background Counts	Source Counts	Net Counts	Figure Of Merit	T1/T2	T2/T4
700	344	2508	2164	1,215.0	2,164.0	0.0
720	407	2764	2357	1,305.9	1,178.5	2.0
740	458	2970	2512	1,380.0	502.4	-5.0
760	520	3197	2677	1,456.5	892.3	-1.0
780	560	3361	2801	1,517.4	233.4	12.0
800	618	3548	2930	1,574.9	586.0	-0.8
820	670	3656	2986	1,591.1	110.6	13.5
840	720	3801	3081	1,632.6	37.6	82.0
860	751	3944	3193	1,690.5	11.8	30.0
880	813	4047	3234	1,697.5	5.2	69.2
900	861	4223	3362	1,760.6	3.3	32.3
920	932	4388	3456	1,798.6	2.6	21.0
940	1019	4672	3653	1,893.7	2.3	7.8
960	1151	4968	3817	1,962.3	2.1	3.5
980	1265	5388	4123	2,115.9	2.1	2.2
1000	1371	5751	4380	2,243.4	2.1	1.7
1020	1503	6160	4657	2,378.5	2.1	1.5
1040	1582	6620	5038	2,579.7	2.1	1.4
1060	1754	7109	5355	2,731.4	2.2	1.3
1080	1859	7582	5723	2,921.3	2.2	1.3
1100	2005	8072	6067	3,092.1	2.3	1.3

Detector: 3



Voltage	Background Counts	Source Counts	Net Counts	Figure Of Merit	T1/T2	T2/T4
700	401	2471	2070	1,126.7	2,070.0	0.5
720	470	2748	2278	1,228.4	2,278.0	0.0
740	520	2974	2454	1,318.2	-1,227.0	2.0
760	567	3191	2624	1,405.6	2,624.0	0.0
780	637	3412	2775	1,474.0	2,775.0	0.0
800	688	3579	2891	1,528.2	206.5	7.0
820	771	3701	2930	1,529.3	112.7	26.0
840	807	3874	3067	1,600.8	35.7	86.0
860	858	3998	3140	1,631.6	10.5	24.8
880	905	4095	3190	1,650.6	4.9	64.7
900	970	4258	3288	1,694.2	3.2	46.5
920	1037	4467	3430	1,762.9	2.6	15.2
940	1132	4772	3640	1,865.6	2.3	5.9
960	1225	4990	3765	1,921.5	2.1	3.1
980	1341	5347	4006	2,039.5	2.1	2.1
1000	1440	5727	4287	2,181.9	2.0	1.6
1020	1552	6067	4515	2,293.6	2.0	1.5
1040	1615	6357	4742	2,410.7	2.0	1.4
1060	1761	6802	5041	2,557.5	2.0	1.3
1080	1830	7167	5337	2,711.7	2.1	1.3
1100	1912	7546	5634	2,865.0	2.1	1.3

Detector: 5



Voltage	Background Counts	Source Counts	Net Counts	Figure Of Merit	T1/T2	T2/T4
700	309	4577	4268	2,737.5	853.6	1.3
720	373	5213	4840	3,072.1	4,840.0	1.0
740	420	5671	5251	3,312.1	5,251.0	0.0
760	463	6120	5657	3,554.3	2,828.5	-1.0
780	525	6571	6046	3,760.7	2,015.3	1.0
800	586	6965	6379	3,929.9	2,126.3	-1.5

Results Report

This report lists the Activity Results between the selected Start and End dates. It is possible to limit the report by Start and End Dates, by the last n results (enter 0 for unlimited results), Alarms Only, Person ID, and Show Raw Counts:

Results Summary

Result ID	Person ID	Result Date	Result Type
3		14/12/2009 13:40	Clean
2		14/12/2009 13:39	Clean
1		09/12/2009 14:33	Clean

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Press on one of the ID records to display the Activity Results Detail for the selected Results ID:

NOTE: The report below is an example and does not display all the information.

Results Detail

Instrument: UKFER-2L3MN3J
Location: Not Set
Result ID: 2
Date: 14/12/2009 13:39:10
Person ID:
Result Type: Clean
Monitor Time (s): 5
Quickscan Time (s): 0
Measurement Confidence: 2

Measured Values

Radiation Type	Measured Value	Uncertainty	MDA / DL	Units	Detector	Stream Name
Gross Gamma	0	20.6	36.2	cps	SCHD	Uncalibrated
Beta	-0.1	2.05	4.8	cps	AR-A	Uncalibrated

Variance Report

This report lists the Background Variance Test Summary Results between the selected Start and End dates. It is possible to limit the report by Start and End Dates:

Background Variance Test Summary

Test ID	Test Date	Radiation Type	Pass / Fail	Cycles	Cycle Duration (s)	Description
2	14/12/2009 13:54:56	Beta	Fail	100	10	
1	14/12/2009 13:54:56	Gamma	Fail	100	10	

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Press on one of the ID records to display the Background Variance Test Results Detail for the selected Test ID:

Background Variance Test Results Detail

Instrument: UKFER-2L3MN3J Location: Not Set

Results ID: 2 Test Date: 14/12/2009 13:54:56

Lower Limit: 0.67 Upper Limit: 1.5

Beta

Detector	Pass / Fail	Alarm Count	VT	Variance Of Counts	Mean (cps)
AR-A	Fail	0	1.891E-28	9.642E-27	5.1
AR-B	Fail	0	1.891E-28	9.642E-27	5.1
AR-C	Fail	0	1.891E-28	9.642E-27	5.1
AR-D	Fail	0	1.891E-28	9.642E-27	5.1
CB1-A	Fail	0	1.891E-28	9.642E-27	5.1
CB1-B	Fail	22	2661	2235000	84
CB1-C	Fail	0	1.891E-28	9.642E-27	5.1
CB1-D	Fail	0	1.891E-28	9.642E-27	5.1
CB2-A	Fail	0	1.891E-28	9.642E-27	5.1
CB2-B	Fail	0	1.891E-28	9.642E-27	5.1
CB2-C	Fail	0	1.891E-28	9.642E-27	5.1

CB2-D	Fail	0	1.891E-28	9.642E-27	5.1
CB3-A	Fail	0	1.891E-28	9.642E-27	5.1
CB3-B	Fail	0	1.891E-28	9.642E-27	5.1
CB3-C	Fail	0	1.891E-28	9.642E-27	5.1
CB3-D	Fail	0	1.891E-28	9.642E-27	5.1
CB4-A	Fail	0	1.891E-28	9.642E-27	5.1
CB4-B	Fail	0	1.891E-28	9.642E-27	5.1
CB4-C	Fail	0	1.891E-28	9.642E-27	5.1
CB4-D	Fail	0	1.891E-28	9.642E-27	5.1
HB-A	Fail	0	1.891E-28	9.642E-27	5.1
HB-B	Fail	0	1.891E-28	9.642E-27	5.1
HB-C	Fail	0	1.891E-28	9.642E-27	5.1
HB-D	Fail	0	1.891E-28	9.642E-27	5.1
HP-A	Fail	0	1.891E-28	9.642E-27	5.1
HP-B	Fail	0	1.891E-28	9.642E-27	5.1
HP-C	Fail	0	1.891E-28	9.642E-27	5.1
HP-D	Fail	0	1.891E-28	9.642E-27	5.1
LB1-A	Fail	0	1.891E-28	9.642E-27	5.1
LB1-B	Fail	0	1.891E-28	9.642E-27	5.1
LB1-C	Fail	0	1.891E-28	9.642E-27	5.1
LB1-D	Fail	0	1.891E-28	9.642E-27	5.1
LB2-A	Fail	0	1.891E-28	9.642E-27	5.1
LB2-B	Fail	0	1.891E-28	9.642E-27	5.1
LB2-C	Fail	0	1.891E-28	9.642E-27	5.1
LB2-D	Fail	0	1.891E-28	9.642E-27	5.1
LB3-A	Fail	0	1.891E-28	9.642E-27	5.1
LB3-B	Fail	0	1.891E-28	9.642E-27	5.1
LB3-C	Fail	0	1.891E-28	9.642E-27	5.1
LB3-D	Fail	0	1.891E-28	9.642E-27	5.1
LB4-A	Fail	0	1.891E-28	9.642E-27	5.1
LB4-B	Fail	0	1.891E-28	9.642E-27	5.1
LB4-C	Fail	0	1.891E-28	9.642E-27	5.1
LB4-D	Fail	0	1.891E-28	9.642E-27	5.1
LF-A	Fail	0	1.891E-28	9.642E-27	5.1
LF-B	Fail	0	1.891E-28	9.642E-27	5.1
LF-C	Fail	0	1.891E-28	9.642E-27	5.1

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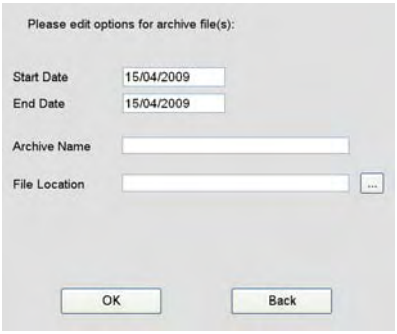
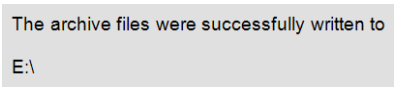
Archives Select Data|Archives to select an Archive to be saved:

To select archives to be saved, highlight the archive on the screen by pressing individual names or press the Select All button. Press the Save to File button to display the edit options window:



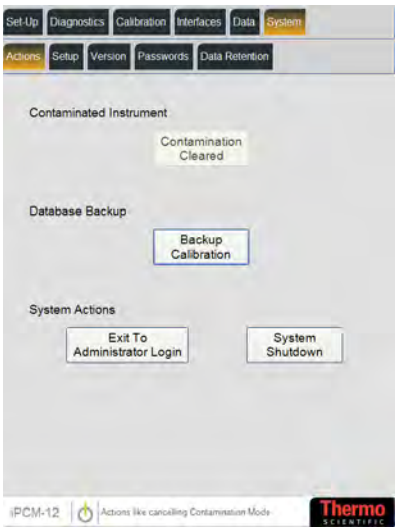
Select a Start / End Date and enter an Archive Name and File Location. Select the OK button to write the archives. A confirmation displays.



System Menu

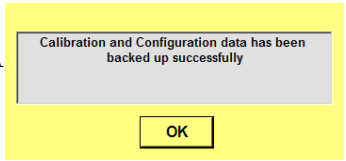
Actions

Select System|Actions to take the iPCM12 out of Contamination Mode, quit the application, or shutdown the system.

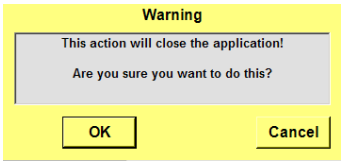


To clear a contamination, press the Contamination Cleared button.

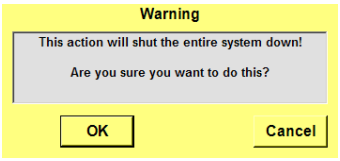
To backup a Calibration, press the Backup Calibration button. A confirmation message displays. Select OK to close the application.



To exit the iPCM12 application, press the Exit to Application Login button. A confirmation message displays. Select OK to close the application.

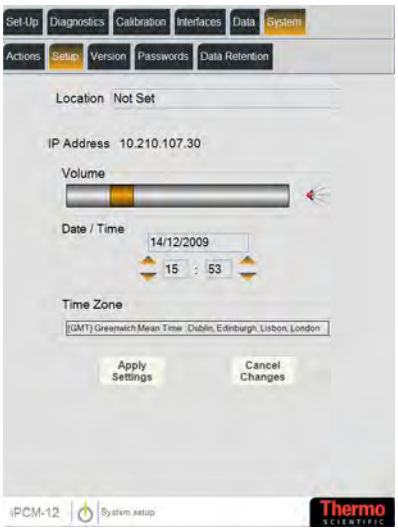


To shutdown the entire system, press the System Shutdown button displays. Select OK to shut the entire system down.



Setup

Select System|Setup to set the location, volume, date / time, and time zone.



To change the Location, enter the location using the alpha-numeric field.

NOTE: The IP address displays on the screen.

To adjust the volume, move the orange bar to the left to decrease the volume and to the right to increase the volume. To test the volume, press the loudspeaker icon. See Notes Regarding Volume Levels (page 5-80).

To change the Date, press the Date field and select a date. Note that the format of the date depends on the Language type selected in the Options screen - see UI Options (page 5-9). Select the Apply Settings button to save.

To change the Time, use the Up/Down buttons to change the hours and minutes. Select the Apply Settings button to save.

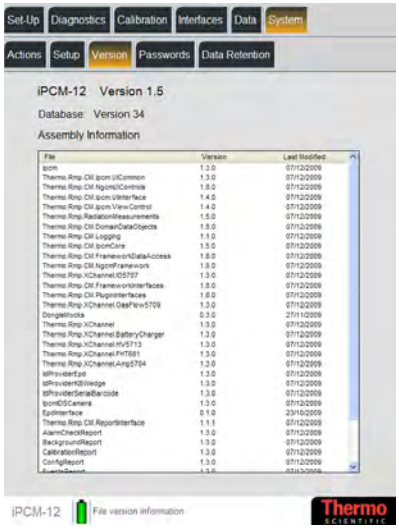
To change the Time Zone, press the Time Zone field and select a time zone from the pre-defined list. Select the Apply Settings button to save.

Notes Regarding Volume Levels

For guidance, 85dBA is obtained at about 35% volume control level and 100dBA at 100% volume control level.

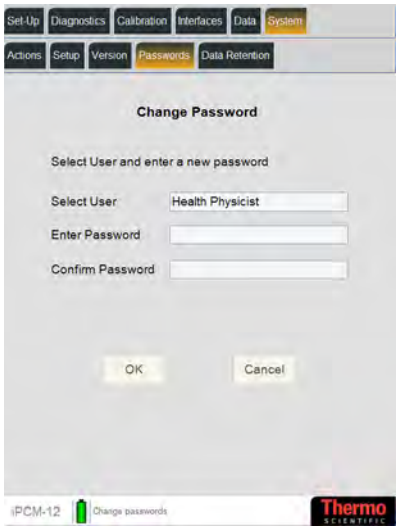
Version

Select System|Version to view the File version information, including the iPCM12 Issue and Version numbers.



Passwords

Select System|Passwords to change the passwords for the current User Level and levels below.



There are three levels of user – Health Physicist, Technician, and ThermoFisher. The iPCM12 is supplied with unique default passwords for each level as follows:

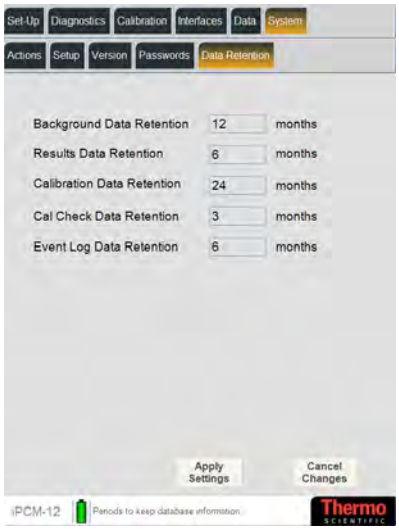
User	Password
Health Physicist	"hp"
Technician	"tech"
ThermoFisher	Contact Thermo Fisher Scientific

To change the Password for a select User, press in the Select User field to display the user roles. Select a User and select OK. Enter a Password and confirm the Password.

Ensure each password level has a unique Password – under no circumstances should all three roles be assigned the same password.

Data Retention

Select System|Data Retention to save the specified data for a set number of months.



Enter the length in time (months) for how long each type of data is to be retained. Data that is older than the specified time will be deleted automatically. The following data types display:

- Background Data Retention (months)
- Results Data Retention (months)
- Calibration Data Retention (months)
- Cal Check Data Retention (months)
- Event Log Data Retention (months)

User Mode

The basic operation of the iPCM12 is as follows:

- Upon power up, system diagnostics are run – see Start up Checks (page 5-87).
- Upon successful system diagnostics, the iPCM12 establishes a new Background – see Establishing a New Background (page 5-89).
- The system enters the Background Monitoring Mode – see Normal Background Monitoring (page 5-91).
- To commence monitoring, the user enters the portal – see Entering the Portal (page 5-94).
- Monitoring starts when the user is correctly positioned in the portal – see Commence Monitoring (page 5-96).
- At the end of the first monitoring position, the instrument may either:
    1. Indicate any contamination and halt the measurement.
    2. If Complete Both Steps is selected (see Operation (page 5-11)), monitoring continues.
- Monitoring may be interrupted due to the result of a Quick Scan assessment (see Operation (page 5-11)) or if a significant change in background conditions is detected during the measurement – see Background Change during Measurement (page 5-101).
- At the end of the Monitoring period, activity is calculated and compared against a set of alarm thresholds for any combination of alpha, beta, or gamma. A simple GO/NO GO indication is given optional display of the details of the location and level of contamination – see Monitoring Result (page 5-102).
- Upon completion of monitoring, the user exits the portal - see Exiting the Portal (page 5-111).

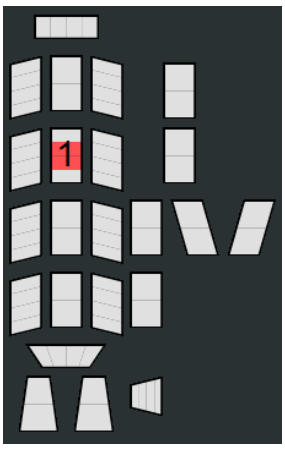
User Screen An example of the iPCM12 screen displays below:

Figure 2 Example of iPCM12 User Screen

The iPCM12 User Screen displays the following:

- Headlines 1 and 2 – note that some of these messages are user-definable - see Messages (page 5-25)
- Detector Indicator – displays where contamination occurs (if present) (see Detector Indicator (page 5-84))
- User Instructions – note that some of these messages are user-definable (see Messages (page 5-25))
- Five-light system that mimics the Annunciator Overlay display (see Five-Light System (page 5-84))
- Thermo Fisher Scientific branding
- Operational Mode display bar – this also gives a description of the selected menu in Administration Mode
- Battery/Mains Supply Indicator (page 5-115)
- Gas Flow Error Indicator (page 5-22)
- iPCM-12 – press here to enter Administrator Mode (page 5-1)

Detector Indicator



Following a measurement, if a contamination is present, the lit detectors identify where the contamination has occurred (see Selecting Detectors (page 5-6) for more information regarding detectors).

Five-Light System

The Five-Light system gives a visual indication of the current operation of the iPCM12.

Ready/Clear	Solid	The iPCM12 is READY for operation
	+ Amber	The result of a measurement is CLEAR.
Recount	Solid	A recount is necessary
	+ Red	User must exit portal before re-entering
Count	Solid	A measurement is in progress
	Flashing	User must move to next measurement position
	+ Green	Measurement Complete – Result CLEAR
Alarm	Solid	An alarm or violation has taken place during measurement OR The iPCM12 is contaminated
	+ White	User must exit portal before re-entering – accompanied by Alarm
	+ Blue	Out of Service – Portal Occupied
Out Of Service	Solid	The iPCM12 is not in use
	Flashing	Out of Service – Acquiring new background
	Fast Flashing	Out of Service – High or Low background
	+ Red	Out of Service – Portal Occupied
	Flashing + Red	Background Acquisition suspended – accompanied by Alarm

Guidance System

The Guidance system gives a visual indication of the current operation of the iPCM12.

Position Body	This LED is lit if the user is not correctly positioned.
Turn Around	This LED is lit when the user is instructed to turn around.
Time Remaining	This LED gives an indication of how much time is remaining for the measurement.

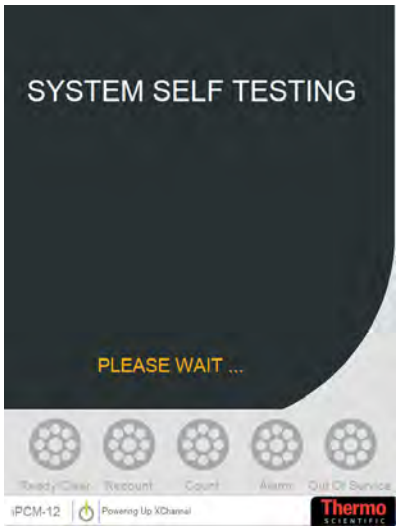
Voice Prompts

NOTE: If Voice Prompts is enabled (see UI Options (page 5-9)), instructions are given verbally. If Voice Prompts is not enabled, an Audible Indication sounds. See Audible Indications (page 3-16) for more information.

Switch On

Cold Start State

When the iPCM12 unit is powered on, the "SYSTEM SELF TESTING" message displays.



In this state, diagnostics are run to validate the state of the iPCM12 to include:

- Database connectivity check (check local database is available)
- Instrument Configuration Data validation
- Instrument Configuration
- XChannel device communication test (check communication with each peripheral)

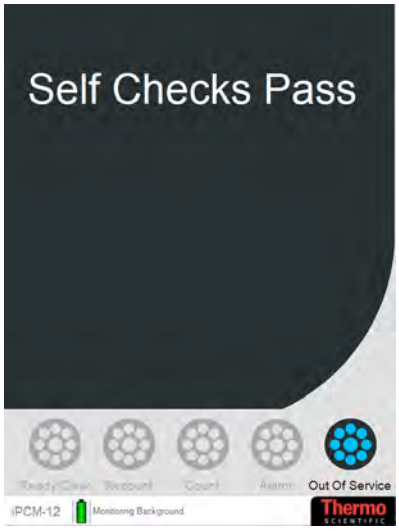
NOTE: After exiting from Administration Mode when an update to the configuration has been made (e.g., change to detector fit or replacement of an amplifier), the Cold Start Mode is entered.

Self Test State

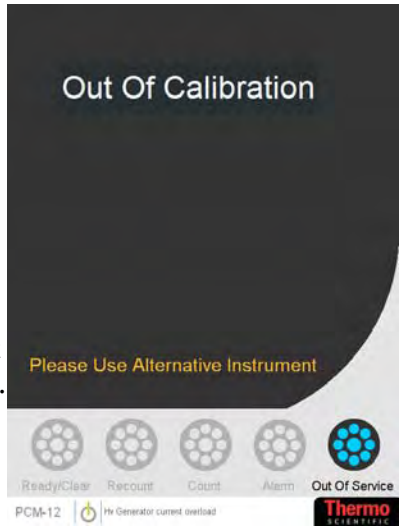
Following the Cold Start checks, the Self Test checks are run.

In this state, additional self tests and configuration are run to validate the state of the iPCM12 to include:

- Selected calibration validity checks (Check efficiency factors are available for all detectors and that at least one valid alarm is set.)
- Loading detector models with efficiencies and alarm thresholds



Upon successful completion of the tests and if beta detection is enabled (see Detection Options (page 5-17)), the gas flow detectors are tested for stability while the gas flow is increased to a purge level.



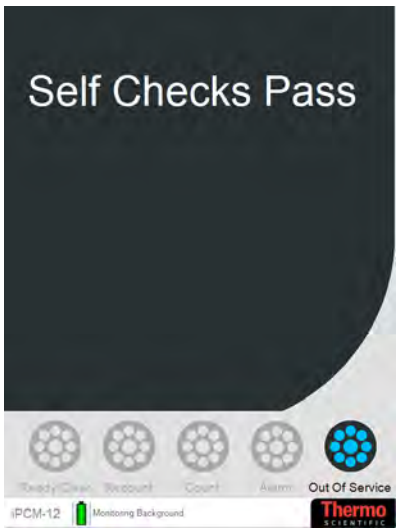
When all gas flow detectors are proved stable, the gas flow is reduced to normal and the current status of the background is tested.

If valid, normal background monitoring resumes (see Normal Background Monitoring (page 5-91)).

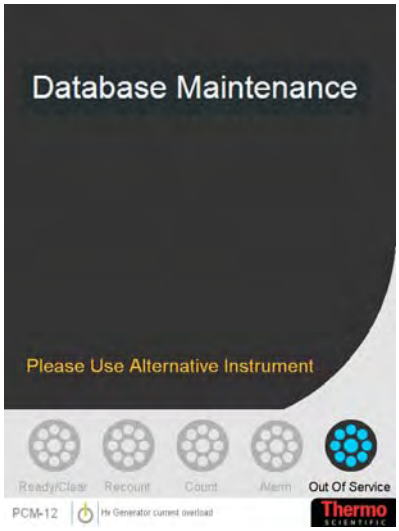
If not valid, background stabilization mode will be entered (see Background Stability Check (page 5-88)).

Start up Checks

If the System Self Testing passes, the "Self Checks pass" message displays for a few seconds.



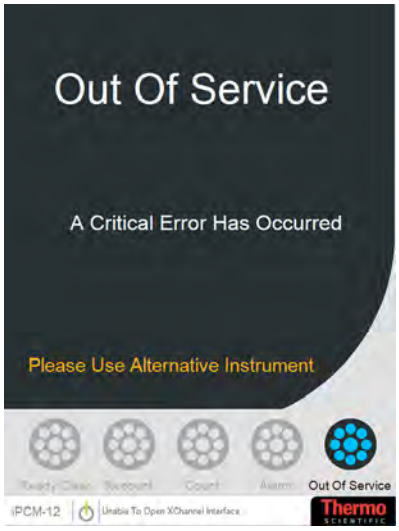
Database connectivity check, i.e., check that the local database is available.



If the System Self Testing fails, the "Out of Service – Critical Error" message displays (the reason for the error may display in the message bar at the bottom of the screen).

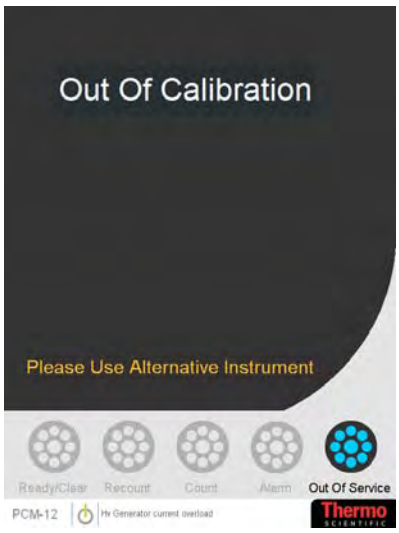
See Out Of Service (page 5-112).

See Maintenance and Trouble Shooting (page 11-1) for more information regarding the Self Test Failures messages.

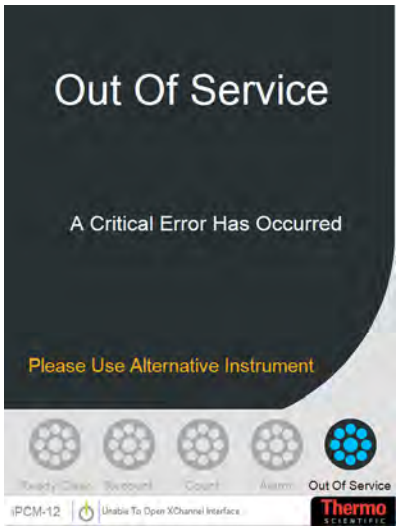


Out of Calibration

If the Calibration Warn Period has been reached, then the "Calibration Warning" message displays – see Calibration (page 5-16). To check the Calibration of the unit, see Cal Check (page 5-39).



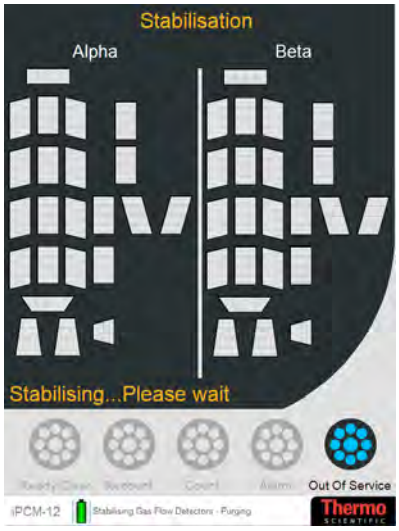
If the Calibration Required Interval option has been exceeded, then the "Out of Service" message displays (note that the reason given for Out of Service displays in the Operational Mode Display Bar) – see Calibration (page 5-16). To check the Calibration of the unit, see Cal Check (page 5-39).



Background Stability Check

If beta detection is enabled (see Detection Options (page 5-17)), the gas flow detectors are tested for stability by increasing to a purge level.

Once these detectors are proved stable, the gas flow is reduced to normal and the current Background Status is tested.



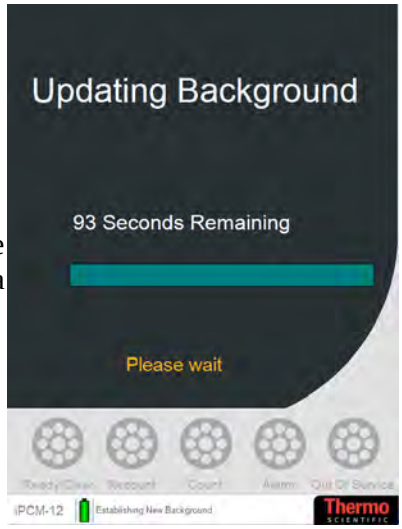
Establishing a New Background

Once the Self Checks have passed, iPCM12 will to acquire a new background and the "Updating Background" message displays.

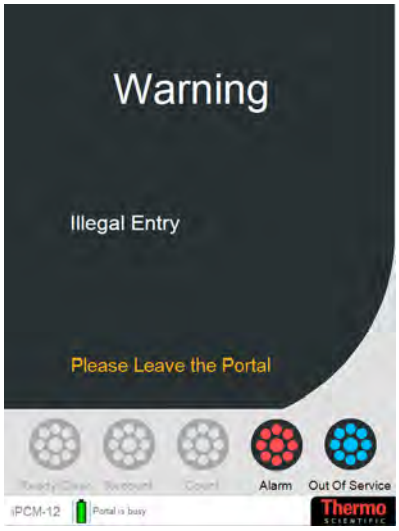
See Notes Regarding Changing Background (page 5-94) for more information regarding acquiring a background.

If Quick Background is enabled (see Operation (page 5-11), the length of time taken to acquire a new background will be much shorter (see Notes Regarding Normal Background Monitoring (page 5-92)).

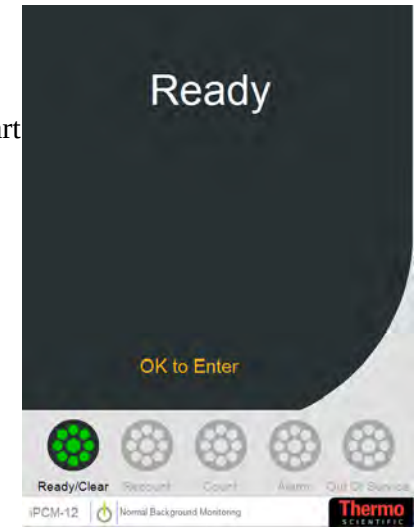
If the background changes during the establishment of a new background, the process will be restarted.



If the portal is entered when the iPCM12 is establishing a new background, background counting stops, the "Warning Please leave the Portal" message displays, and an audible alarm sounds. To continue with the process, the portal must be vacated.

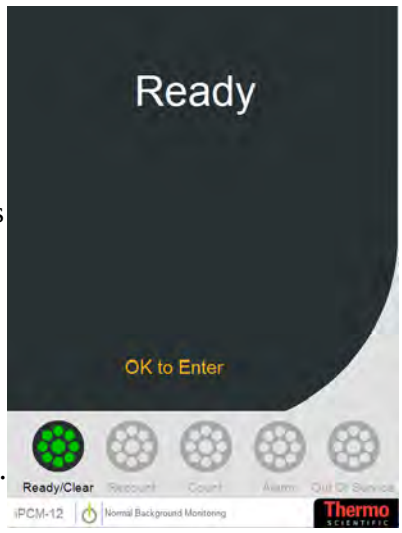


When a new Background has been established, the "Ready – OK to Enter" message displays. The iPCM12 is now ready to start monitoring contamination.



Normal Background Monitoring

This is the normal dormant state of the system. Normal Background Monitoring is continuous until:



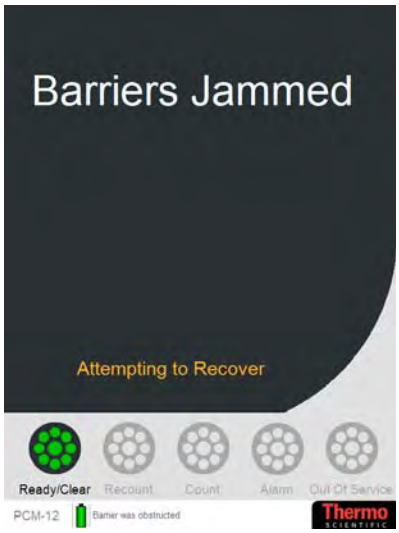
1. One or more of the position sensors are triggered (probably as part of a measurement cycle) – see Entering the Portal (page 5-94) for more information.

2. A change in background is detected – see Changes to the Normal Background Monitoring (page 5-92) for more information.

3. A high background condition is detected - see Notes Regarding High Background (page 5-113) for more information.

If the Barrier Enabled and the Ingress Closed When Ready options are selected (see Detection Options (page 5-17)), the user is unable to pass through the barrier while the Ready message displays.

If there is a problem with the Door / Barrier, the "Barriers Jammed" message displays. If the system is unable to recover, the Out of Service message displays (see Barrier Error (page 5-113)).



Notes Regarding Normal Background Monitoring

Alpha and Beta Backgrounds

The backgrounds will be monitored over a 100 second period in 10 second blocks. At the end of each 10 second accumulation, the 10 second background will be compared with the prevailing 100 second background to assess for changing background or counts out of range conditions on the detectors before adding it into the current 100 second background.

Gamma Backgrounds

The background will be monitored over 1 second check periods. Each 1 second period will contribute to a rolling average of up to 100 periods.

Because a contaminated user approaching the instrument may affect the background of the instrument, all background counts are pre-buffered for the Portal Approach Time (see Operation (page 5-11)) before being incorporated into the main background of the instrument. When a person is detected entering the instrument, these pre-buffered background counts are discarded.

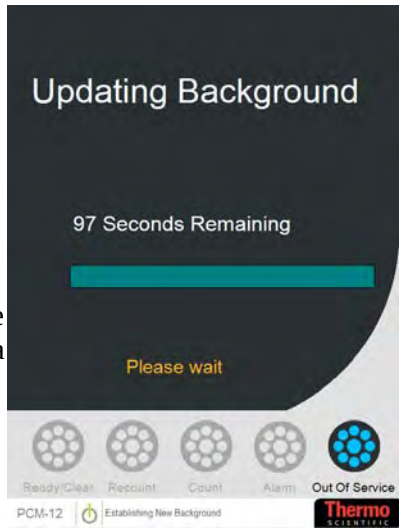
Quick Background

The background accumulation period is dynamic. The instrument will remain "Out of Service" for as long as it takes to acquire a stable background and results in a count time lower than the Maximum Monitoring Time (see Monitoring (page 5-14)).

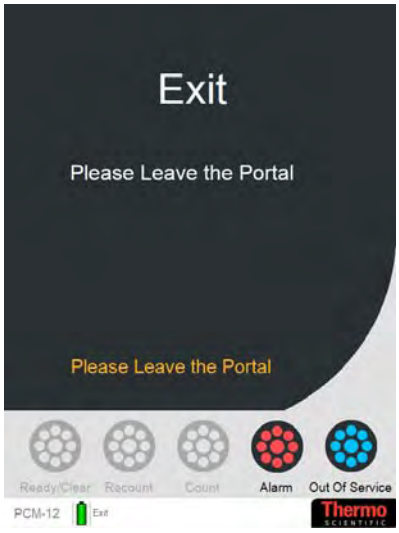
Changes to the Normal Background Monitoring

If a change in the Normal Background Monitoring is detected or the instrument does not have a valid background, the iPCM12 will acquire a new background and the "Updating Background" message displays.

See Notes Regarding Changing Background (page 5-94) for more information regarding acquiring a background.

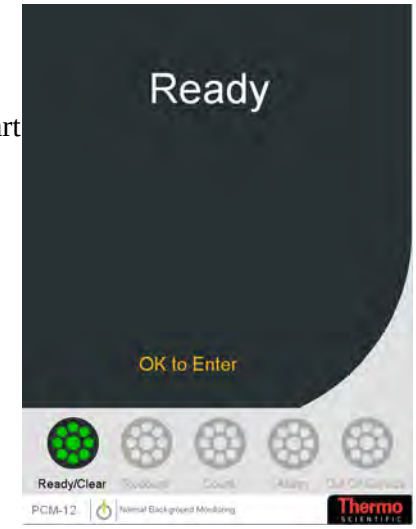


If the portal is entered when the iPCM12 is updating the background, background counting stops, the "Warning Portal is busy" message displays and an audible alarm sounds. To continue with the process, the portal must be vacated.

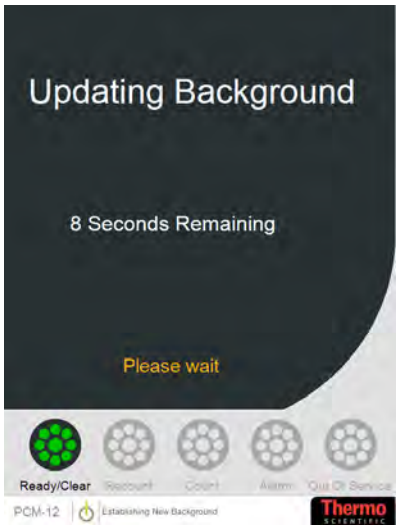


When a new Background has been established, the "Ready – OK to Enter" message displays. The iPCM12 is now ready to start monitoring.

See Entering the Portal (page 5-94) for more information.



If more than 15 minutes of continuous operation have elapsed since Normal Background Monitoring has commenced, the iPCM12 will acquire a new background and the "Updating Background" message displays.



Notes Regarding Changing Background

When a changing background has been detected or the instrument does not have a valid background (e.g., at System Startup), the system establishes a new background radiation measurement.

Each one-second Background count for each detector is checked against user defined statistical limits for variance from the stored average for that channel. If the count is acceptable, it is incorporated into the stored average; otherwise, the stored average for all channels is discarded, the blue Alarm lamp lights, and the "Updating Background - Please Wait" message displays while a fresh 100 second Background is accumulated - see Background Update (page 6-13) for more information.

NOTE: If Quick Background is selected, the length of time taken to acquire a new background will be much shorter (see Operation (page 5-11)).

Personnel Monitoring

Entering the Portal

The iPCM12 can be configured with the following options to control how personnel use the portal (see Operation (page 5-11) for further information):

- Is a User ID Required (see User ID (page 5-94))?
- Is a camera installed to take a picture of the user (see Camera (page 5-62))?

User ID

The iPCM12 may be fitted with an external device on either or both sides of the portal to provide identification of the user. This device may include, but is not limited to, one of the following device types:

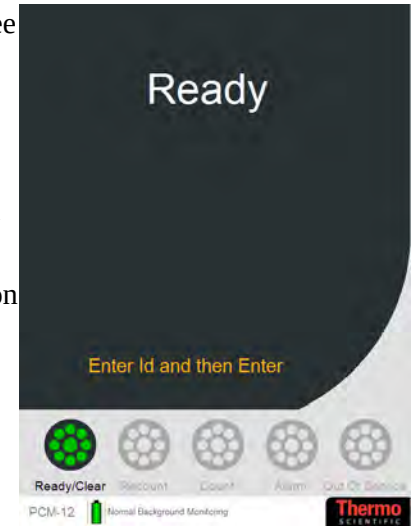
- Barcode scanner
- Magnetic swipe card reader
- RFID reader
- Electronic Dosimeter reader
- Keypad

NOTE: When a device is fitted, the user must enter the portal from the same side as the reader.

If User ID Required is ticked (see Operation (page 5-11)), the user is requested to enter their ID before entering the portal.

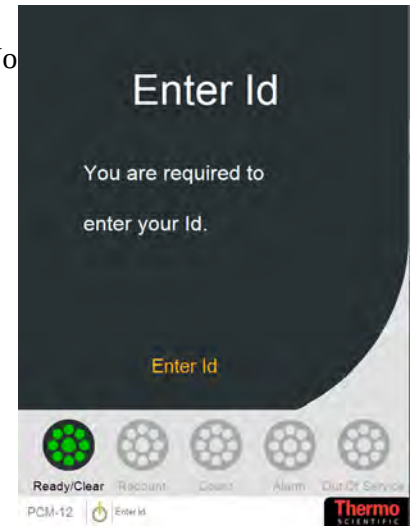
See Voice Prompts (page 5-85) for information regarding verbal instructions.

The user scans their identification at the barcode reader. The measurement process will not continue until this is successful.



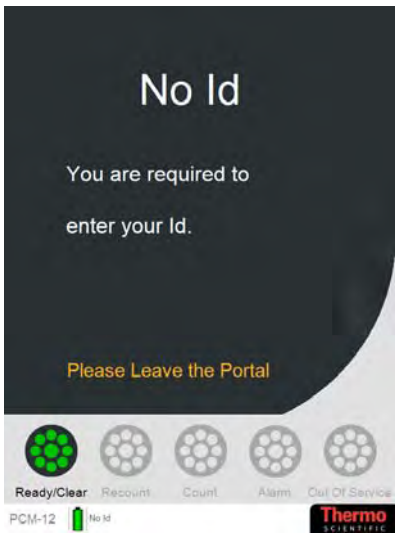
If the user enters the portal without entering their ID, the "No ID" error message displays:

See Voice Prompts (page 5-85) for information regarding verbal instructions.



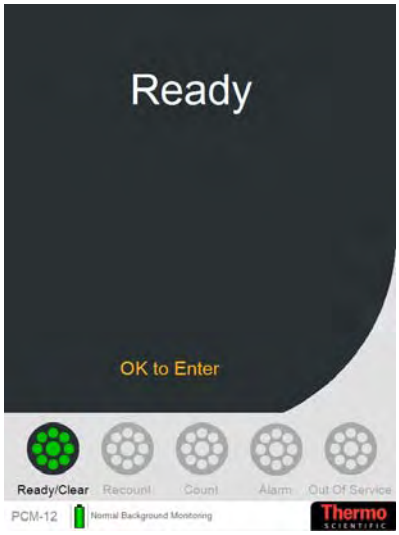
If the User does not enter the portal within the Id Timeout Period (see Operation (page 5-11), the user is asked to leave the portal.

See Voice Prompts (page 5-85) for information regarding verbal instructions.



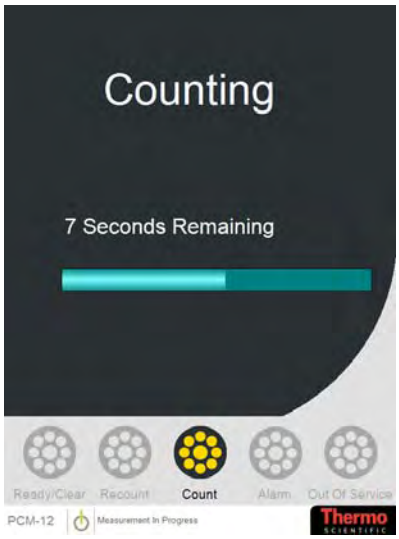
If User ID Required is not ticked, the iPCM12 displays the "Ready - OK to Enter" message:

The user enters the portal to commence the measurement process.



When the user steps into the portal and is in position correctly, the count commences.

See Positioning (page 5-97).



Camera

If Camera(s) is/are installed (see IDS Camera (page 5-59), a digital picture of the user is automatically taken as they enter the portal, depending on the Camera on Alarm option set in UI Options (page 5-9).

The iPCM12 is able to recognize when the camera is used by detecting which beam is broken (see Position Sensors (page 5-31)).

Commence Monitoring

The Personnel Monitor can be configured to use a two-step measurement, with the user facing the detector array for the first step and then rotating 180 degrees to face away from the measurement array for the second step. See Positioning (below).

Positioning

If Complete Both Steps is enabled, the user is instructed to position him/herself correctly in the Portal. One or a combination of the following messages displays, depending on whether the sensors are broken (see Position Sensors (page 5-31):

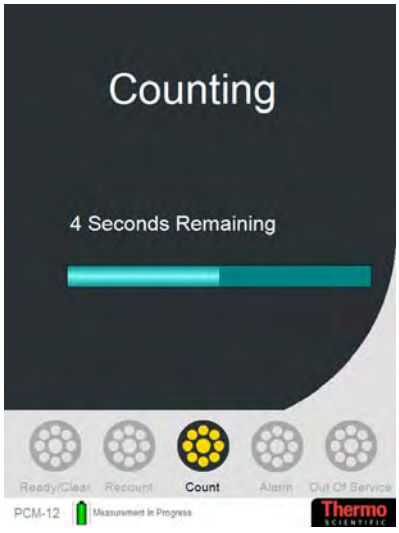
- Face In, Head turned Left
- Insert Left Foot
- Insert Right Foot
- Insert Right Hand
- Move Right Hip Closer

See Voice Prompts (page 5-85) for information regarding verbal instructions.

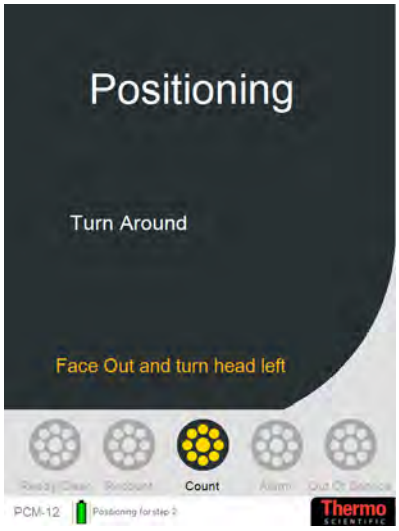
When the user is in the correct position, measurement starts:

Once monitoring commences, the iPCM12 displays the "Counting" message with an indication of the measurement time remaining.

If Complete all Steps (see Operation (page 5-11)) is not ticked and contamination is detected, the result displays at this stage and the measurement process is terminated (see Alarm Result (page 5-104).



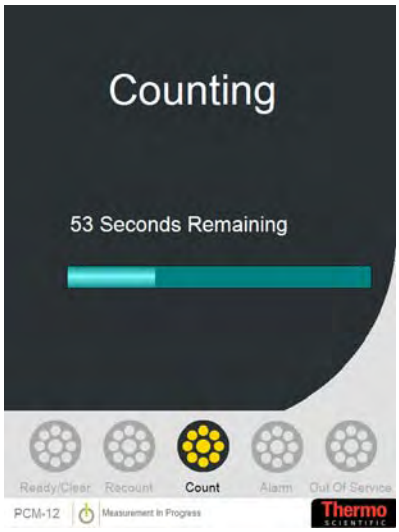
If the front measurement is satisfactory, then the user is instructed to turn around. One or a combination of the following messages displays, depending on whether the sensors are broken (see Position Sensors (page 5-31)):



- Face In, Head turned Left
- Insert Right Foot
- Insert Left Foot
- Insert Left Hand
- Move Left Hip Closer

See Voice Prompts (page 5-85) for information regarding verbal instructions.

When the user is in the correct position, measurement continues:



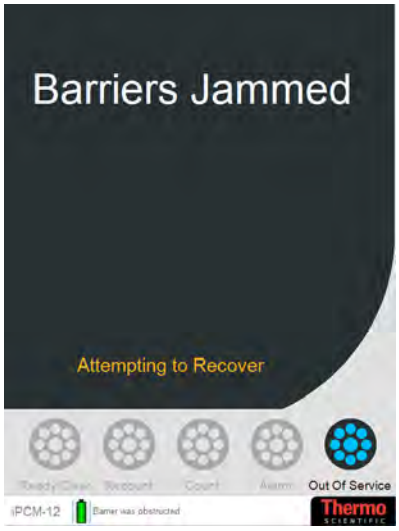
Once monitoring commences, the iPCM12 displays the "Counting" message with an indication of the measurement time remaining.

On completion, the result displays. See Monitoring Result (page 5-102).

Violations during Monitoring

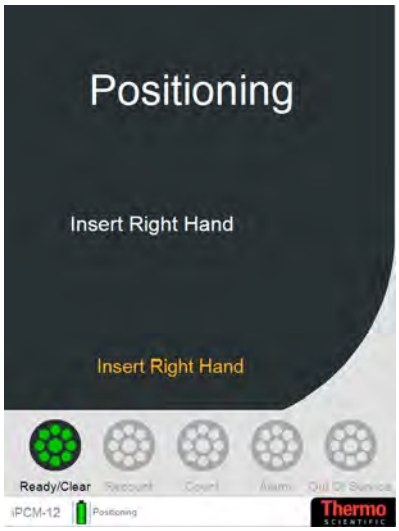
If a user exits the portal or moves out of position (determined by the optical position sensors) before the measurement is complete, the instrument sounds an alarm and illuminates the recount lamps. If the user re-enters the portal or repositions him/herself correctly, then the measurement will be resumed. If the user has exited the portal and does not return to the correct position within a configurable timeout, then the measurement is abandoned and the instrument will return to background monitoring.

If the Barriers become stuck during the measurement, the "Barriers Jammed" message displays. If this is recoverable, the measurement will continue. If not, the unit becomes Out of Service (see Barrier Error (page 5-113)).



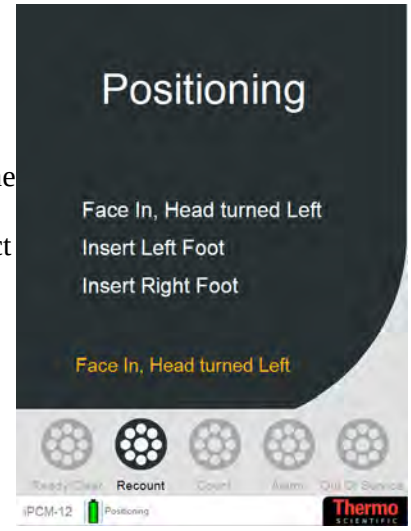
If, during measurement, the user moves from the specified position, a "Positioning" message displays, asking them to return to position.

If the user re-positions him/herself in the portal and Restart Measurement on Sensor Break (see Operation (page 5-11))
is ticked, the measurement will restart. If Restart Measurement on Sensor
Break is not ticked, the measurement will resume. If the user does not return to the correct position within the Exit Barrier Delay (see Operation (page 5-11)), the "Measurement Abandoned"
message sounds.



See Voice Prompts (page 5-85) for information regarding verbal instructions.

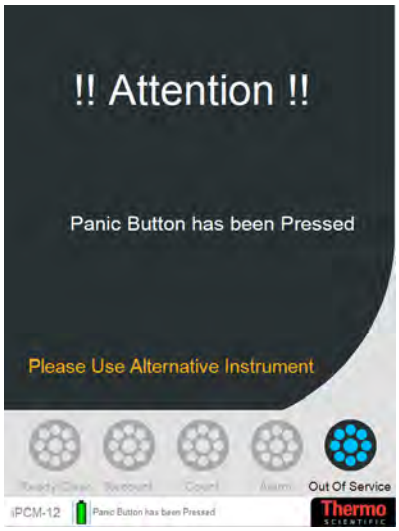
If, during measurement, the user exits the portal before the measurement is complete, the "Positioning" message displays.



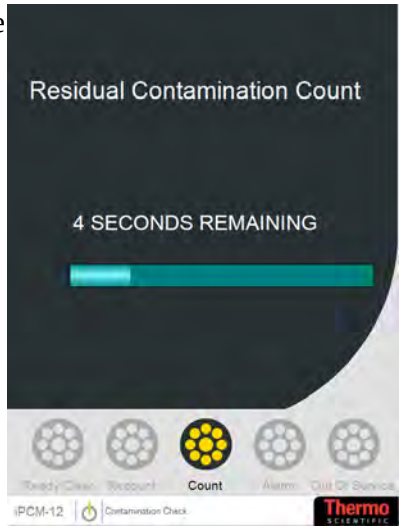
If the user re-enters the portal, the measurement resumes. If the user does not return to the correct position within the Exit Barrier Delay (see Operation (page 5-11)), the "Measurement Abandoned" message sounds.

See Voice Prompts (page 5-85) for information regarding verbal instructions.

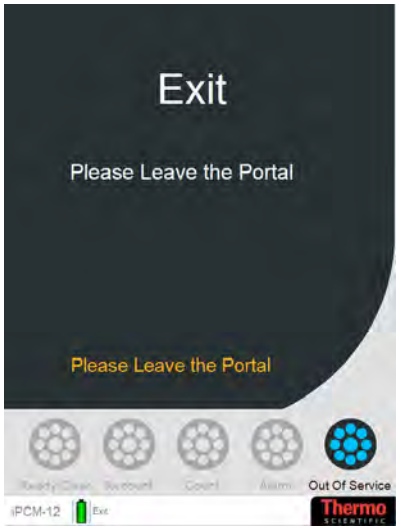
If the user presses the panic button during the measurement, the “Panic Button Pressed” message displays and the instrument is disabled. Intervention by an Administrator is necessary to clear the message.



Following an abandonment, if the RCC after Abandoned Measurement option is ticked (see Operation (page 5-11)), the Residual Contamination Count is performed (see Residual Contamination Check (page 5-108)).



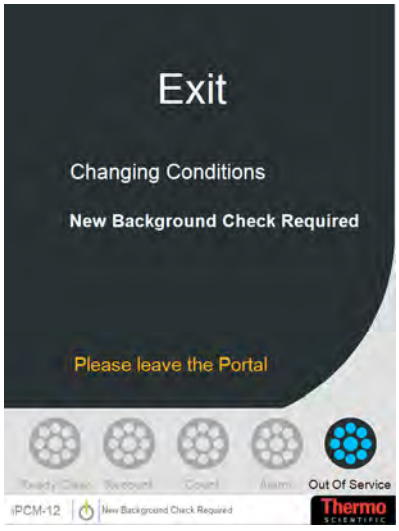
If the user does not fully exit the portal on completion of measurement, the "Exit" message displays:



See Voice Prompts (page 5-85) for information regarding verbal instructions.

Background Change during Measurement

If a change in background is detected during a measurement, the user is instructed to exit the portal:



A new background check is required before monitoring can resume. See Changes to the Normal Background Monitoring (page 5-92).

Monitoring Result

An example of the result screen displays below:

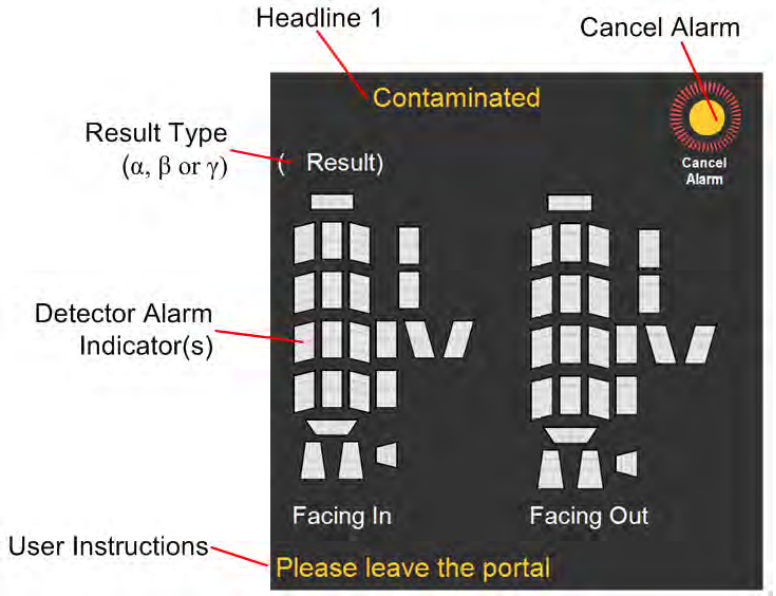


Figure 3 Example of Result display on the iPCM12 User Screen

The iPCM12 result screen displays the following:

- Headline 1 displays the type of Alarm

  Some of these messages are user-definable - see Messages (page 5-25).

- Cancel Alarm

  For more information regarding user acknowledgement of alarm, see Cancel Alarm (page 5-108).

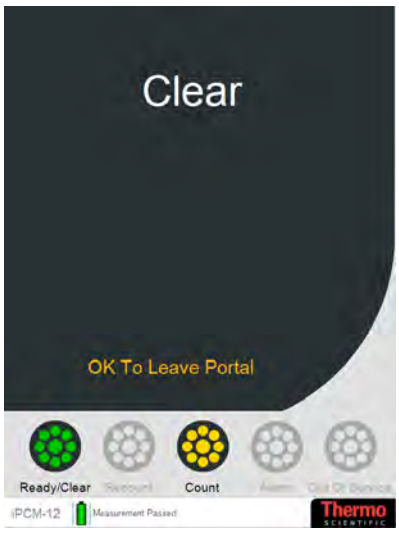
- Result Type
- Detector Alarm Indicator, see Detector Indicator (page 5-84)
- User Instructions

  Some of these messages are user-definable, see Messages (page 5-25).

For more information regarding the options available to display results, see UI Options (page 5-9) and Operation (page 5-11).

CLEAR Result

If the measured contamination is below the alarm level or when Quick Scan indicates real-clean, the user is informed audibly and visually of the result, with instructions to exit the portal. The "Clear" message displays.



See Voice Prompts (page 5-85) for information regarding verbal instructions.

This message is user-definable. See Messages (page 5-25) for more information.

At the end of the measurement sequence, the stored total background count is subtracted from the total measured count to give the net count, which is compared with the effective alarm level.

CAUTION: THE iPCM12 CANNOT DISTINGUISH BETWEEN A GRADUAL BUILD-UP OF CONTAMINATION AND SMALL BACKGROUND CHANGES. THEREFORE, IT IS STRONGLY RECOMMENDED THAT A REGULAR FRISKING PROCEDURE IS ADOPTED AND/OR AN INSPECTION OF THE BACKGROUND REPORT SHOULD INDICATE A BUILD-UP OF ACTIVITY – SEE **Reports (page 5-63).**

Notes Regarding Monitoring

Measurement Cycle

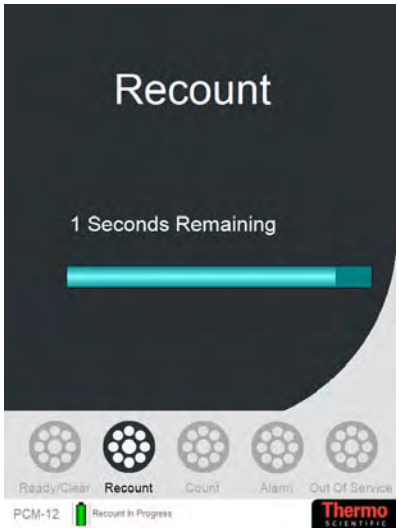
During the measurement, the amount of measurement time remaining displays on the screen (see Personnel Monitoring (page 5-94) and on the Guidance System (page 5-85).

QuickScan

It is possible to determine quickly during a measurement that the sample is either clean or contaminated and if the count rate is sufficiently low or high. This is known as QuickScan. This feature is enabled separately for beta and gamma (it is not applicable to alpha) – see Operation (page 5-11).

Recount Required

If the user moves out of position during the measurement cycle, the count is halted and the user is prompted to move back into position. The following "Recount Required" message displays. If the user moves back into position, then the count resumes. If the user leaves the portal, then the measurement is abandoned.



Alarm Result

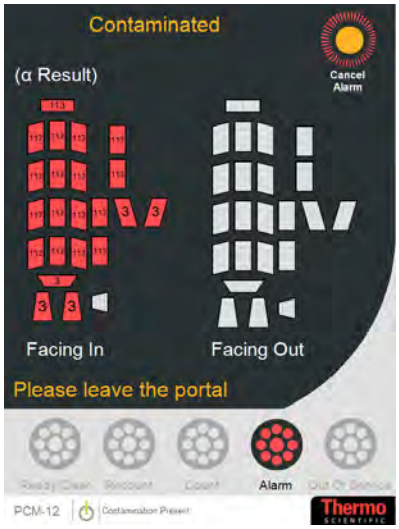
See Alarms (page 5-19) and Alarm Display (page 5-106) for more information regarding the Alarm displays.

If the measurement is partially complete and the α Low Background Limit is exceeded or when Quick Scan indicates real-dirty, the "Contaminated" message displays, indicating that contamination is present.

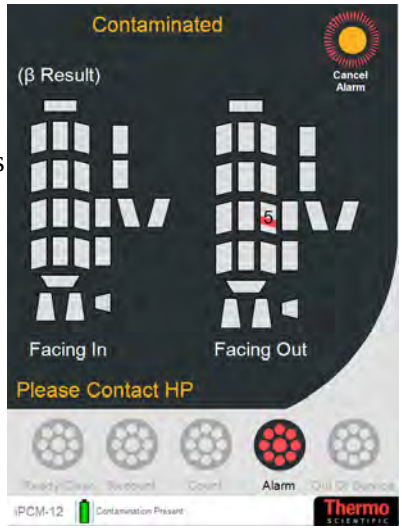
See Voice Prompts (page 5-85) for information regarding verbal instructions.

This message is user-definable. See Messages (page 5-25) for more information.

See Cancel Alarm (page 5-108) for more information on clearing the alarms.



If the measurement is complete and the β Low Background Limit is exceeded or when Quick Scan indicates real-dirty, the "Contaminated" message displays indicating that contamination is present.

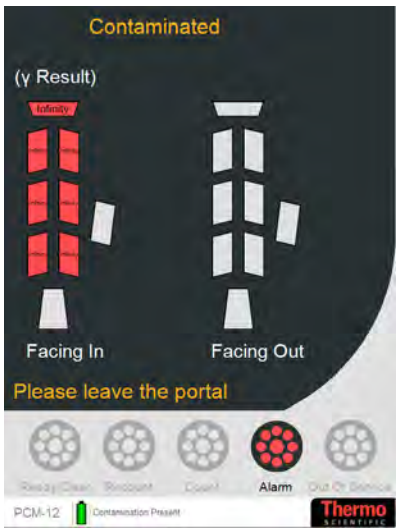


If the measurement completes and the γ Low Background Limit is exceeded or when Quick Scan indicates real-dirty, the "Contaminated" message displays indicating that contamination is present.

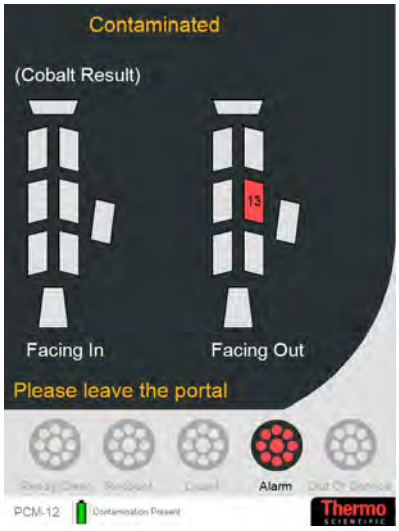
See Voice Prompts (page 5-85) for information regarding verbal instructions.

This message is user-definable. See Messages (page 5-25) for more information.

See Cancel Alarm (page 5-108) for more information on clearing the alarms.



If the measurement completes and the ^{60}Co Low Background Limit is exceeded or when Quick Scan indicates real-dirty, the "Contaminated" message displays, indicating that contamination is present.



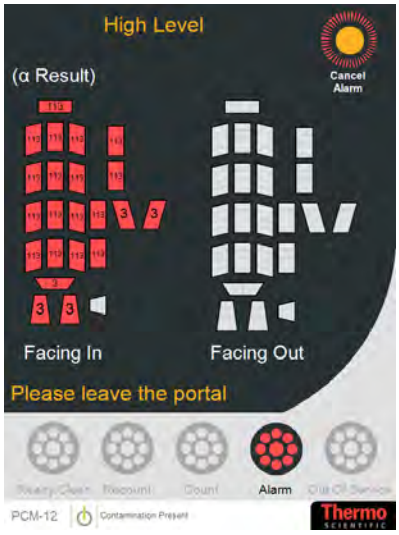
See Voice Prompts (page 5-85) for information regarding verbal instructions.

This message is user-definable. See Messages (page 5-25) for more information.

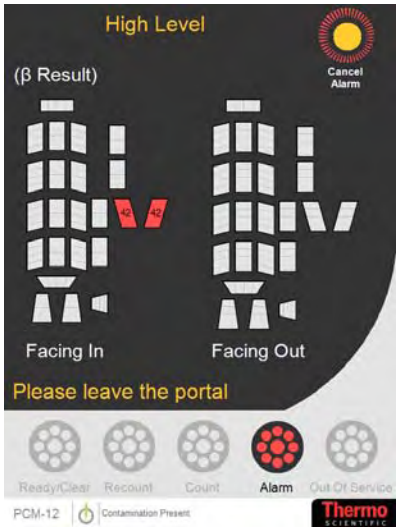
See Cancel Alarm (page 5-108) for more information on clearing the alarms.

Alarm Display

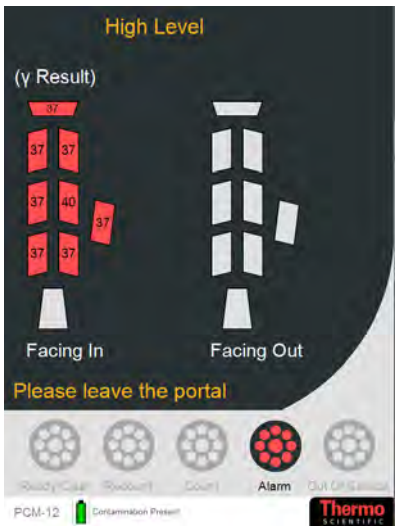
If the α High Alarm is triggered, the information displays as follows:



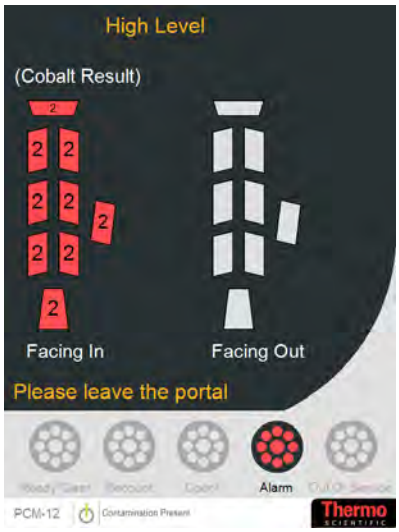
If the β High Alarm is triggered, the information displays as follows:



If the γ High Alarm is triggered, the information displays as follows:

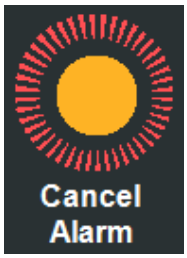


If the ^{60}Co High Alarm is triggered, the information displays as follows:



Cancel Alarm

For more information about setting of Alarm configurations, see Alarms (page 5-19).



When an Alarm displays and sounds, it can be cleared in the following instances:

1. The alarm will automatically timeout after the Alarm Duration After Exit setting.
2. If User Can Cancel Alarm Sound is ticked, the User can acknowledge the alarm prior to the Alarm During After Exit timeout.
3. If Failure Display requires Supervisor Acknowledge is ticked, the alarm will display/sound until the Supervisor acknowledges the alarm (The Alarm Duration After Exit timeout is ignored in this case).

Residual Contamination Check

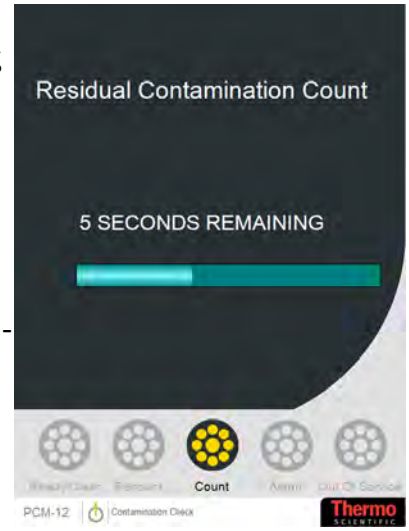
Following an alarm, if the Residual Contamination Check after Alarm option is ticked (see Operation (page 5-11)), the Residual Contamination Count is performed.

See Notes Regarding Residual Contamination Check (page 5-109) for more information.

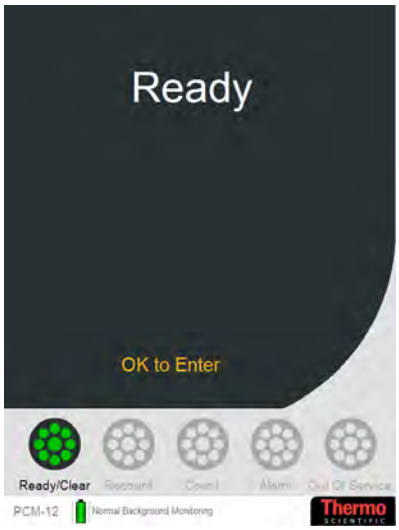
Notes Regarding Residual Contamination Check

The Residual Contamination Check is run under the following circumstances:

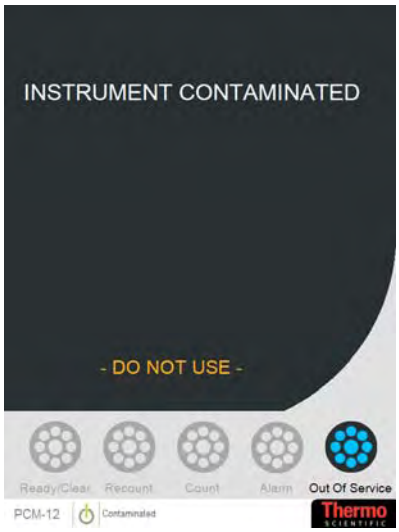
- If the Residual Contamination Check after Abandoned Measurement option is set - see Operation (page 5-11).
- If Residual Contamination Check after Alarm option is set - see Operation (page 5-11).



The Residual Contamination Check will verify that the current background count rate does not exceed the Background Count Rate before the alarm by a statistically significant amount. If no contamination is found, the "Ready – OK to Enter" message displays and the iPCM12 reverts to Background mode.



However, if residual contamination is detected or the count rate from any detector exceeds 95% of the Amplifier "dead-time", then an Instrument Contaminated state exists. The "INSTRUMENT CONTAMINATED – DO NOT USE" message displays (see Instrument Contaminated (page 5-110) for more information).



If the portal is entered during the Residual Contamination Check, the "WARNING – Preparing for Contamination Check" message displays.

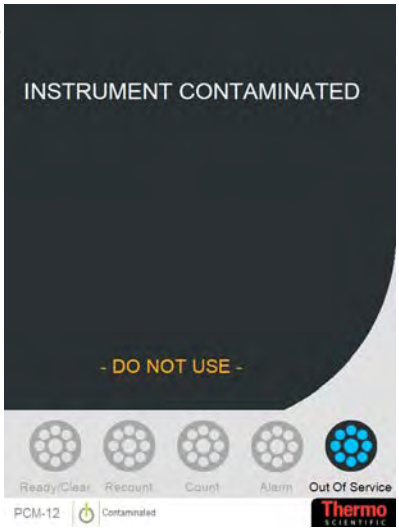
See Voice Prompts (page 5-85) for information regarding verbal instructions.

Once the Portal is exited, the Residual Contamination Count recommences.

Instrument Contaminated

If the Instrument is contaminated, it is not possible to use the portal and background monitoring is suspended. Intervention by an Administrator is necessary to clear the contamination.

See Actions (page 5-78) for more information regarding clearing the Contamination.



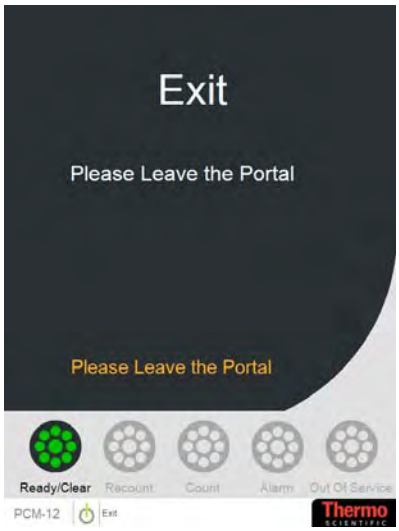
Once the contamination has been cleared, and User Mode is re-instated, the iPCM12 performs the System Self Testing – see Start up Checks (page 5-87).

Exiting the Portal

The iPCM12 provides the following options to control how personnel exit the portal:

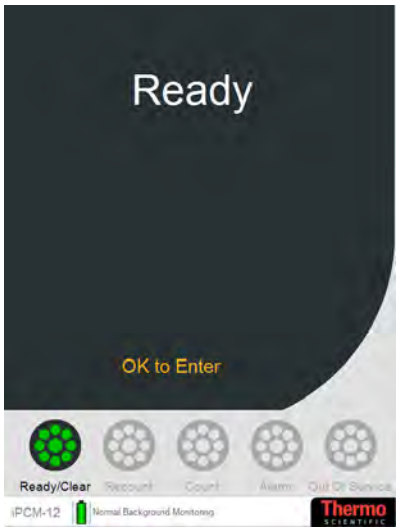
- Alarm Duration After Exit (see Operation (page 5-11))
- Enable Rear Barrier (see Detection Options (page 5-17))

After a result displays, the user must exit the portal.



After an ALARM result, the alarm will sound for the length of time set in Alarm Duration after Exit (see UI Options (page 5-9)).

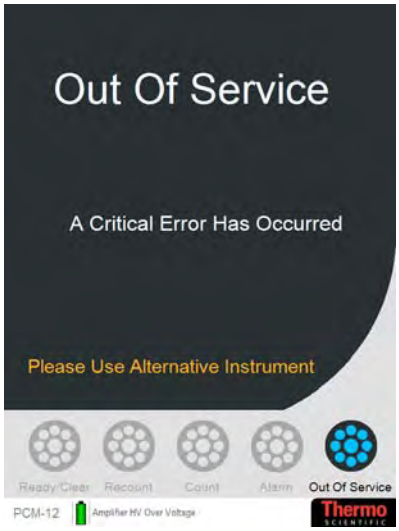
Once the user has successfully vacated the portal, the "Ready" message displays:



Out Of Service

Non-recoverable

If the Switch On tests fail or a failure is detected during normal operation, the "Out of Service – Critical Error" message displays (The reason for the error may be displayed in the message bar at the bottom of the screen).



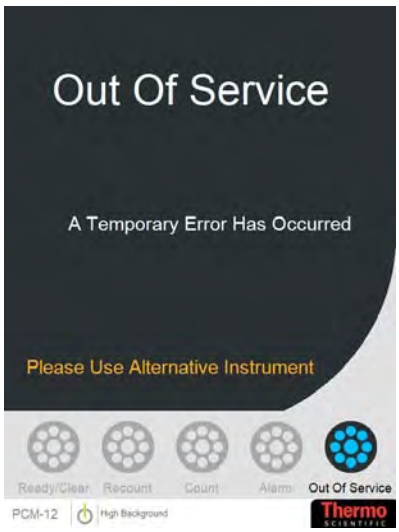
See Voice Prompts (page 5-85) for information regarding verbal instructions.

To clear this error, the state must be cleared in the Administration Mode (or will clear automatically when the Out of Service Recovery Interval is passed, see Operation (page 5-11) for more information).

See Actions (page 5-78) for more information regarding clearing the Critical Error.

Temporary Error

If a High Background event (see Notes Regarding High Background (page 5-113) or Low Background Count Rate (see Notes Regarding Low Background (page 5-114)) is detected, the "Out of Service – Background Error" displays. During this state, normal background monitoring will continue.



If the fault clears without intervention, the instrument will resume normal operation.

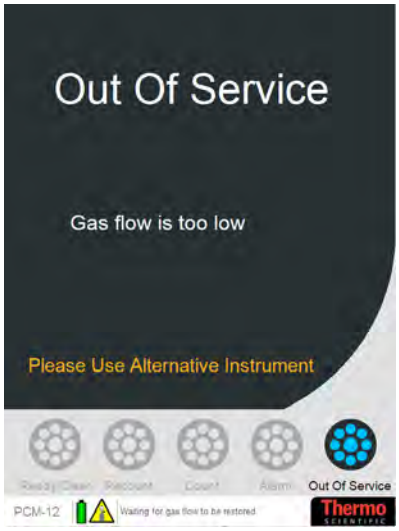
See Voice Prompts (page 5-85) for information regarding verbal instructions.

Gas Flow

If a Low or High Gas Flow is detected, (see Gas Flow (page 5-22), the "Out of Service – Gas flow is too low/high".

If the fault clears without intervention, the instrument will resume normal operation.

See Voice Prompts (page 5-85) for information regarding verbal instructions.

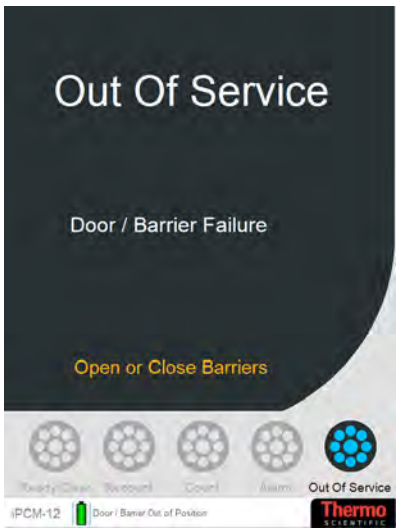


Barrier Error

If the iPCM12 detects an error with the Door or Barrier, the "Out of Service – Door / Barrier Failure" error message displays. During this state, normal background monitoring will continue.

If the fault clears without intervention, the instrument will resume normal operation.

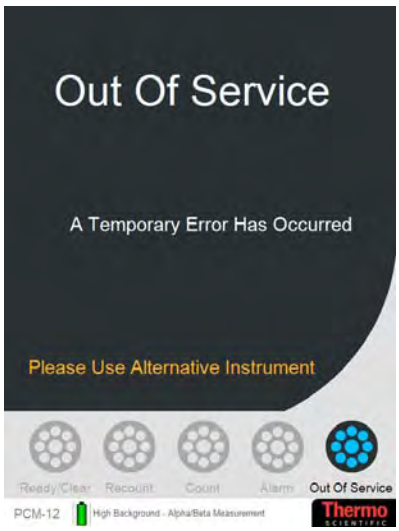
See Voice Prompts (page 5-85) for information regarding verbal instructions.



Notes Regarding High Background

The "Out Of Service – High Background" message displays if a high background condition exists.

See Voice Prompts (page 5-85) for information regarding verbal instructions.



As each new set of background count is processed, the monitoring time will be determined. If the calculated sample monitoring time exceeds the user specified Maximum Monitoring Time (see Monitoring (page 5-14)), a high background condition exists and further measurements are not possible. The instrument will enter the "Out of Service" state with an indication of the reason for being out of service, e.g., "High Background Conditions".

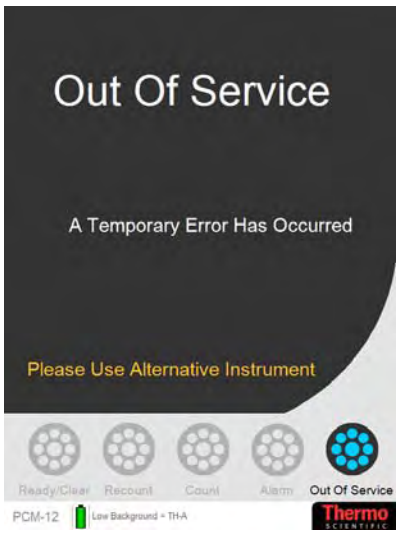
Background measurements will continue as described until the background count rate drops to a level where the calculated monitoring time is acceptable.

It is also possible to exit the high background condition if an administrator increases the Maximum Monitoring Time or decreases the Measurement Certainty.

Notes Regarding Low Background

The "Out Of Service – Temporary Error has Occurred" message displays if a low background condition exists.

See Voice Prompts (page 5-85) for information regarding verbal instructions.



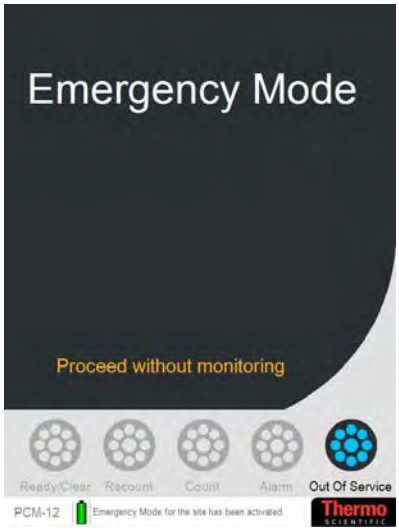
If the count rate falls below the Low Background limit (see Monitoring (page 5-14)), the "Out of Service – Low Background Counts Detector" message displays.

For alpha and beta counts, this is evaluated over the 10 second accumulated background. For gamma counts, this is evaluated for each 1-second background count.

The iPCM12 will remain in this state until the background count rate once again exceeds the threshold on all detectors.

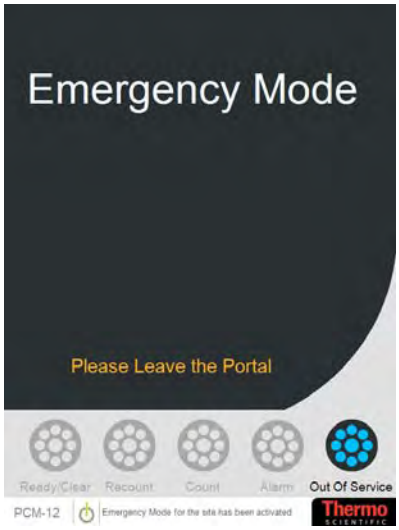
Emergency Mode

"Emergency Mode" displays if the system is put into Emergency Mode.



If the portal is entered during the Emergency Mode, the "Please leave the Portal" message displays.

See Voice Prompts (page 5-85) for information regarding verbal instructions.



Battery/Mains Supply Indicator

On the main screen, an icon displays on the bottom edge of the screen that indicates whether the iPCM12 is running on battery or mains supply as follows:

Indicates that the iPCM12 is running on battery.

See Battery (page 5-36) for more information regarding Battery Status including remaining battery life.

This icon indicates that the iPCM12 is running on mains supply.

Switch Off

Only an Administrator is able to exit the iPCM12 application – see Actions (page 5-78).

Chapter 6 Technical Description – Physics

Performance Characteristics

Introduction

The iPCM12 utilizes 21 identical large gas flow detectors with, optionally, 3 additional detectors. There are 12 detectors in a body array, which has a sculpted design for best fit around the body. In addition, there are a side of head and a shoulder as well as two hand and two foot detectors. An optional side of foot, top of head, and spare purged detector are also available.

The instrument is designed to measure alpha, beta, and gamma contamination on the body, hands, and feet of an operator. Because an operator's hands and feet are in direct contact with the respective hand and foot detectors, performance characteristics for the monitoring of contamination on the extremities is directly related to the efficiency figures given in Specification (page 3-1) for hands and feet for the alpha/beta detectors.

This Section is primarily concerned with the performance characteristics of detecting contamination on the body (legs, torso, and head).

In order to obtain high efficiency from low energy betas and to obtain a good all around spatial response, the operator must be close to the detectors. The body Sensor ensures this by forcing the operator to interrupt a photo beam with his torso to initiate monitoring. To obtain good spatial response, the detectors must 'fit' the operator. The general shape of the body is:

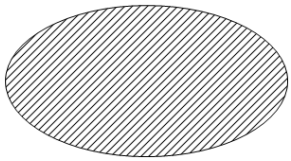


Figure 4 Elliptical phantom

This requires a detection layout of six vertical arrays:

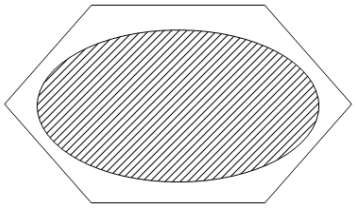


Figure 5 Perfect layout of alpha/beta detector

By having three pseudo-vertical arrays and a half-full-height leg array and by instructing the operator to turn around, the six vertical array system is achieved around the upper half of the body, and eight vertical arrays surround the lower half of the body. The size of the operator has little effect on sensitivity.

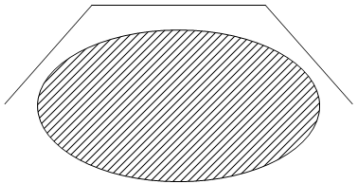


Figure 6 iPCM12 alpha/beta detector layout, in one step

In the case of alpha monitoring, the range of alpha particles in the air is only a few centimeters (dependent on alpha energy), so many parts of the body will not be close enough to allow detection of contamination. However, alpha monitoring may be thought worthwhile for those parts of the body and legs in near contact with the detectors. The form of detector layout again provides the best arrangement for the detection of alpha contamination with a static system.

In the case of gamma monitoring, although good counting geometry is required, closeness of the body to avoid air absorption is not required, so detector arrays behind the beta detectors give very uniform responses.

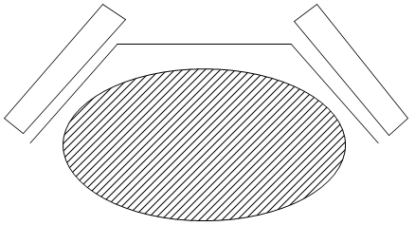


Figure 7 iPCM12 detector layout including gamma detectors

The iPCM12 combines the results from adjacent detectors to provide sum zones that monitor for distributed contamination over more than one detection area. This leads to an excellent overall spatial response on all regions of the body.

Spatial Response

Great difficulty is experienced in determining the actual performance of the equipment for the monitoring of personnel, because of variation of height and shape of the users. The standard IEC 61098 "Installed personnel surface contamination monitoring assemblies for alpha and beta" emitters published by the International Electrotechnical Committee (IEC) overcomes these problems by providing a standard technique for combining results from a vertical efficiency scan and horizontal efficiency scan around an elliptical phantom, to provide an overall efficiency. Using this technique, a comparative assessment can be made.

Vertical Scans

Figures 8 and 9 show the variation of response for a point Beta source placed at 5 cm from the center of the middle detector and moved in a vertical plane. The figures refer to Co-60 and Cl-36, respectively. Figures 10 and 11 illustrate the vertical response to Co-60 and Cs-137 gamma emissions, respectively.

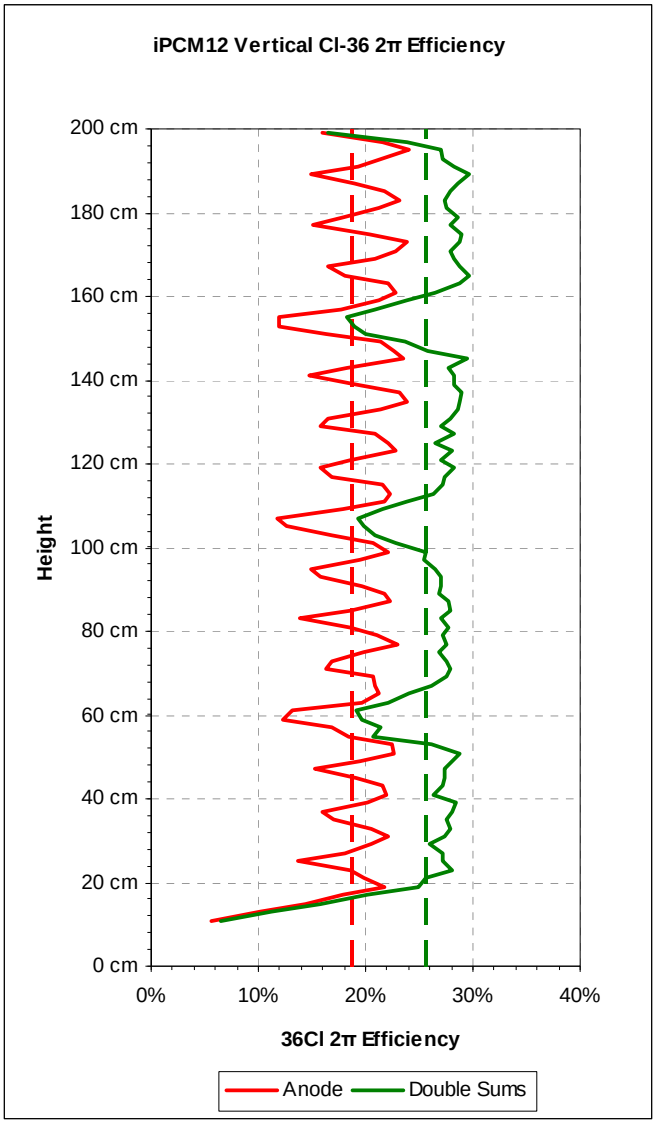


Figure 8 ^{36}Cl Beta – Vertical Scan – Rugged Grille

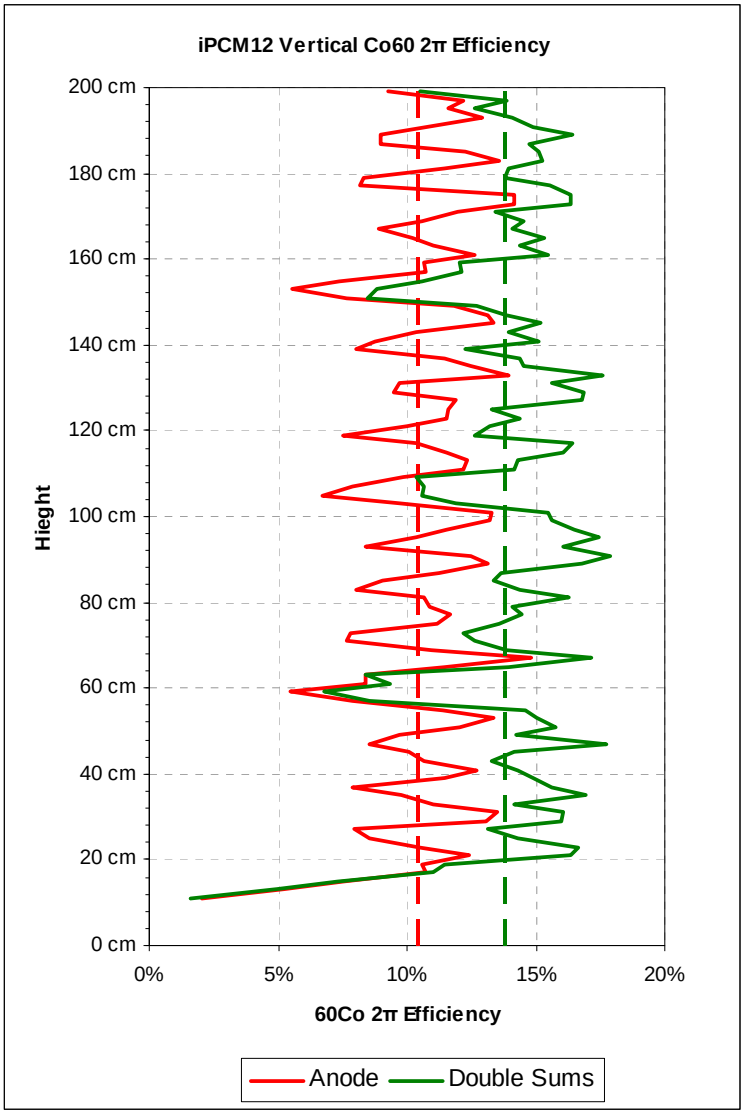


Figure 9 ^{60}Co Beta – Vertical Scan – Rugged Grille

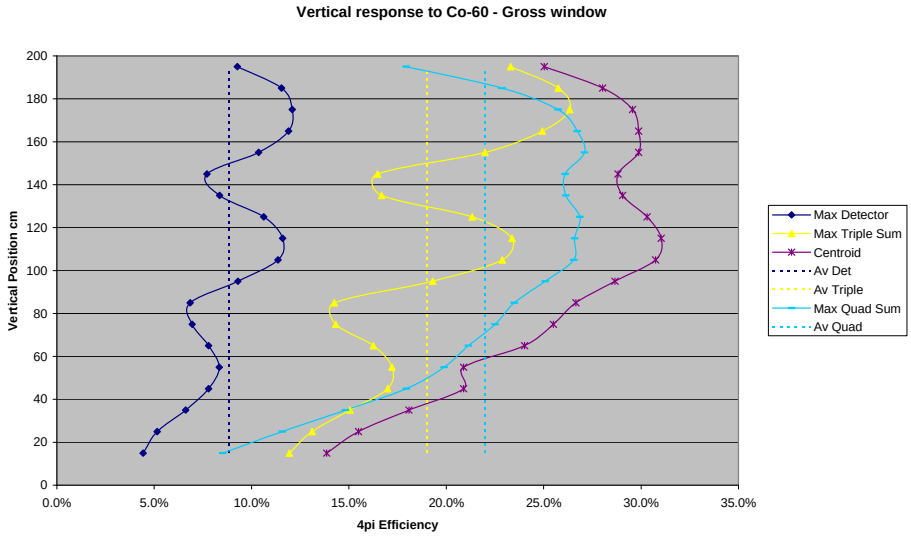


Figure 10 ^{60}Co Gamma – Vertical Scan – Rugged Grille

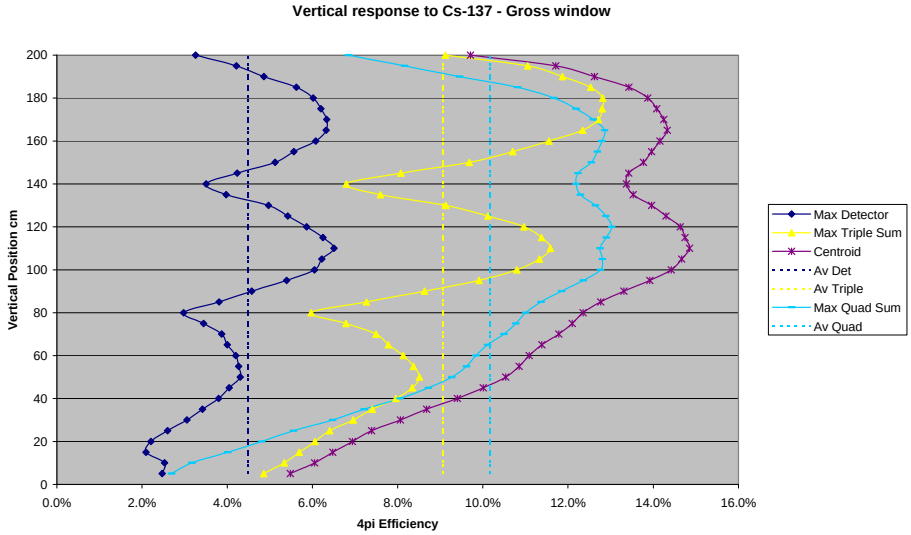


Figure 11 ^{137}Cs Gamma – Vertical Scan – Rugged Grille

Horizontal Scans

Figures 12 and 13 show the variation of response for a point beta source placed at 5 cm from the closest detector and moved in a horizontal plane around the phantom. The figures refer to Co-60 and Cs-137, respectively. These response curves are for a source on the lower half of the body at the height of maximum efficiency in the vertical plane. Figures 14 and 15 illustrate the horizontal response to gamma emissions from Co-60 and Cs-137, respectively, at a height of 110 cm.

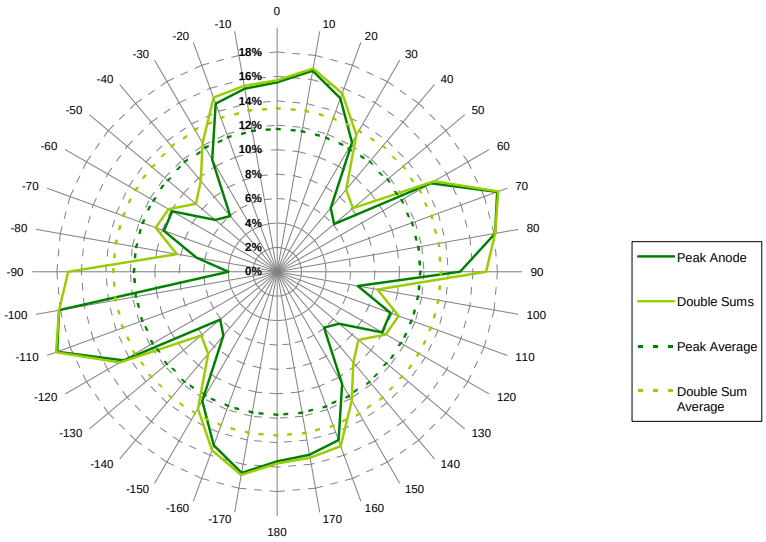


Figure 12 ^{36}Cl Beta – Horizontal Scan – Rugged Grille

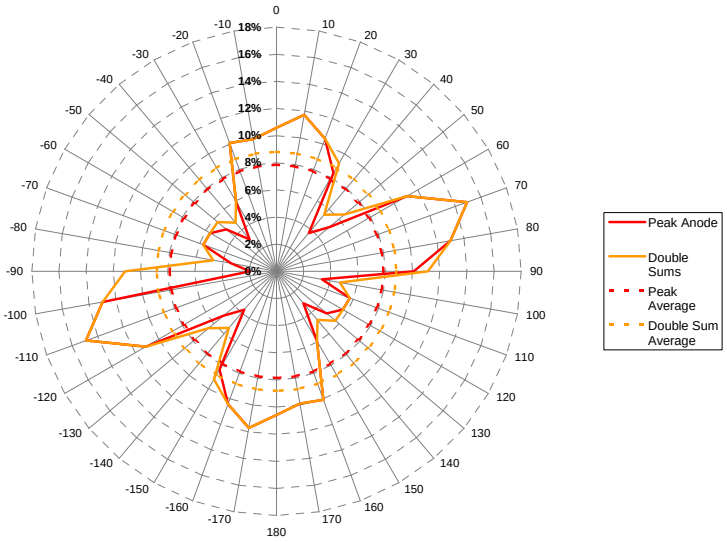


Figure 13 ^{60}Co Beta – Horizontal Scan – Rugged Grille

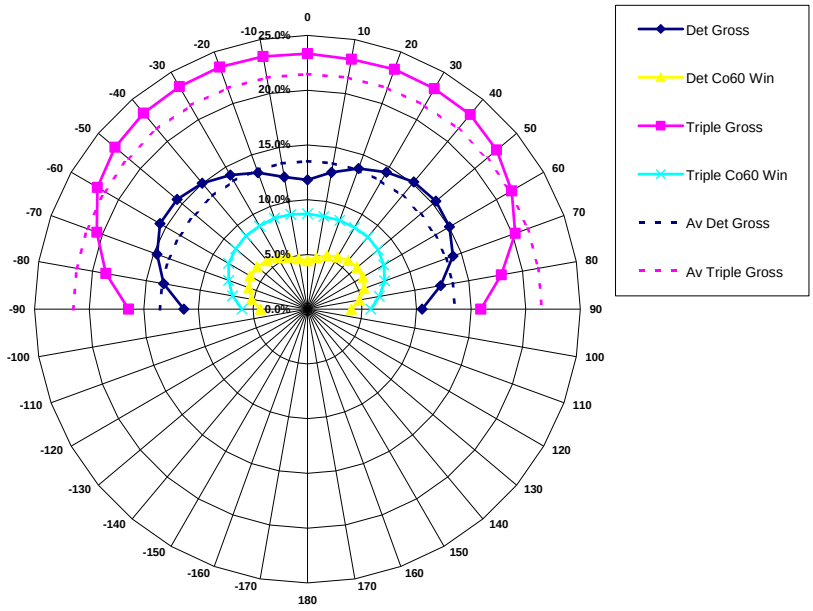


Figure 14 ^{60}Co Gamma – Horizontal Scan

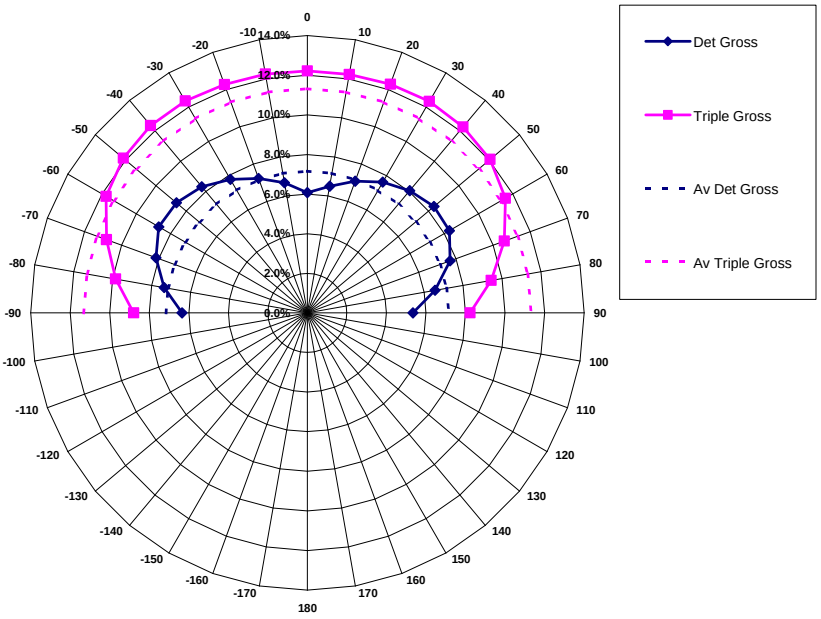


Figure 15 ^{137}Cs Gamma – Horizontal Scan

Body Efficiencies

Following the procedures identified in IEC 61098, the overall Beta efficiency to activity in the body region is evaluated by combining (1) the mean to peak ratio of the vertical scan (Figures 8 to 11) and (2) the mean polar response obtained from the horizontal scans (Figures 12 to 15).

Body Average Efficiency (BAE) is expressed in terms of activity (4π) and is given by:

BAE = Mean / Peak Vertical Ratio × mean Horizontal polar efficiency

The BAE for key radionuclides is shown in Alpha and Beta Detection Efficiencies (page 3-8).

A full type test report is available from Thermo Fisher Scientific on request.

Summing

As can be seen from all Figures 8 to 15, there are areas of low efficiency at the interface between two anode zones for the beta detectors (for beta) and detectors (for gamma). Therefore, if we add the efficiency of two adjacent zones together we achieve a much better efficiency. This improvement in efficiency is, however, off-set by the fact that, with two zones/detectors, the background count-rate is doubled. Because the performance in terms of minimum detectable activity is proportional to the square root of the background, summing of the efficiency of adjacent counters is only advantageous if the sum is $\sqrt{2}$ greater than either of the individual efficiencies.

Similarly, for gamma detectors, summing the results of four detectors meeting at a point has advantages only if the scan is twice that due to any individual counter or $\sqrt{2}$ times the sum of two adjacent counters.

Radon Rejection

"Nuisance" Alarms can occur due to naturally occurring Radon gas. Radon gas from the ground and concrete constructions tends to be statically attracted to hair and clothing, particularly in dry and poorly ventilated areas. The primary alpha and beta "daughter" emissions are readily detected by gas-flow counters in close proximity to the body.

Radon alpha decay typically has two associated beta daughter emissions within approx. 62 µs of each alpha emission.

This beta/alpha ratio of 2:1 is only approximate because the precise nature of radon changes with its age, area of origin, and climatic conditions throughout the course of the day.

Alarms detected with a beta/alpha radio of approximately 2:1 can therefore be associated with nuisance Radon. In addition, if the system identifies the timing between the alpha and beta events, filtering should be possible to remove Radon/Thoron events.

In practice, site specific beta/alpha Radon ratios are determined and a minimum/maximum ratio may be set as a parameter within the application.

"Genuine" Alarms take precedence over possible Radon alarms. Alarms within the defined ratio range area deemed possible nuisance alarms trigger an "ALARM – possibly due to Radon" message to the user.

Usually, re-monitoring after 15-20 minutes will allow any Radon to decay and a clear result to be obtained.

Explanation of the Operational Calculations

Introduction

It is a requirement to measure personnel contamination as quickly and accurately as possible. Optimum detection efficiencies are required, with minimum statistical error in giving alarm indications. Measurement of contamination is dependent on ambient background level. Accuracy of measurement of both background and contamination is dependent on respective background and contamination monitoring times, background attenuation, and also on chosen probability of false alarm and probabilities of detection.

This section summarizes the calculations employed by the system in determining whether the parameters selected by the user allow the monitor to operate correctly.

Description of Parameters Used in Calculations

The parameters used in the calculations are summarized and abbreviated as follows:

t_B **Background Update Time (seconds)** is the time over which the average background counts have been accumulated. This time is usually fixed at 100 s, but when Quick Background is enabled, this time is flexible and may be significantly lower than 100 s. Background measurements can only occur when the portal is not occupied.

B_{sum} **Average Background Count Rate (cps)** is the mean background of the detectors, measured over the background update time (**t_B**). This is a fixed 100 second rolling average in the iPCM12, unless Quick Background is enabled. See Notes Regarding Normal Background Monitoring (page 5-92).

B_{eff} **Effective Background while Monitoring (cps)** is the mean background of the detector, B_{sum}, corrected for the effect of attenuation.

T_{cal} **Calculated Monitoring Time (seconds)** is the minimum time required to perform a measurement according to the calculation in Calculation of the Monitoring Time (Tcal) (page 6-15). The specified alarm level must be achieved with the required certainty in the Monitoring Time, which will depend upon a number of user programmable variables as well as the Background.

T_{mon} **Actual Monitoring Time (seconds)** is the actual time for which users are monitored. The calculated monitoring time (T_{cal}) is first rounded up to the nearest whole second. It is then compared with the user programmed Minimum Monitoring Time (T_{min}) and if $T_{cal} < T_{min}$ then T_{mon} is forced to be T_{min}, otherwise $T_{mon} = T_{cal}$. If $T_{mon} > T_{max}$ then a high background condition exists and normal monitoring is not possible (see Calculation of the Monitoring Time (Tcal) (page 6-15)).

T_{min} **Minimum Monitoring Time (seconds)** is the Minimum Time for which users are monitored, regardless of the calculated Monitoring Time; see explanations of Tcal and Tmon above. The Minimum Monitoring Time is set in Monitoring (page 5-14).

T_{max} **Maximum Monitoring Time (seconds)** is the maximum time for which users are monitored, regardless of the calculated Monitoring Time; see explanations of T_{cal} and T_{mon} above. The Maximum Monitoring Time is set in Monitoring (page 5-14).

C_{Act} C**ontamination Alarm Level (variable unit)** is the activity level at which the user requires the alarm to be triggered. The alarm level is set in Alarms (page 5-19) and the units, e.g., dpm, Bq, nCi, can be selected in UI Options (page 5-9).

C_{cps} **Contamination Alarm Count-rate (cps)** is the count-rate at which the user requires the alarm to be triggered. It is equivalent to the Contamination Alarm Level set by the Administrator modified by the system Efficiency Correction Factor (E).

C_{effect} **Effective Alarm Count rate (cps)** is the effective net count rate at which the iPCM12 normal alarm is triggered. The Contamination Alarm Count rate is modified to take account of the monitoring time, background statistical fluctuation, and user programmed Probability of Detection. This ensures the Alarm set point reflects the measurement certainty required. The current Effective Alarm count rate may be viewed in Information (page 5-29). The C_{effect} calculation is detailed in Contamination Alarm (page 6-17).

F **Probability of False Alarm (σ)** is the probability that a false alarm does not occur during a measuring sequence. The value of F in terms of sigma is set in Detection Options (page 5-17), where the associated probability is shown alongside in parenthesis. The value is usually set as high as possible so that false alarms do not occur; e.g., one false alarm in a hundred measurements is a probability of 99% (2.4 σ), see Table 1 Probability - Sigma and % (page 6-22).

P **Probability of Detection (σ)** is the probability that exactly one Alarm Level of contamination will cause an alarm. The value of P in terms of sigma is set in Detection Options (page 5-17), where the associated probability is shown alongside in parenthesis. The minimum allowable probability is 50% (zero sigma). Increasingly higher probabilities become increasingly subject to other parameters, particularly background level. The interrelationship will be discussed in the Calculation stages.

E **Efficiency Correction Factor** is the system efficiency (either sum zone efficiency for multiple detectors, or individual detector contact efficiency) to the nuclide (E_{nuc}) or mixture of nuclides (E_{mix}) being monitored. E is given by the contamination count rate in a given time and divided by the activity. E is determined by calibrating with a known radionuclide source, as detailed in Calibration for Other Nuclides (page 10-5).

A **Attenuation Factor** is an allowance for attenuation of a background field by users being monitored. Values of A can be determined for each detector and body position by following the test procedure in Detectors (page 5-27).

DL **Detection limit** or Minimum Detectable Count Rate (cps)

M_{Act} **Minimum Detectable Activity (variable unit)** is the minimum Activity the system can detect within the calculated monitoring time. It is very dependent on the programmed False Alarm rate and the prevailing background conditions and thus will continuously vary. The current Minimum Detectable Activity (MDA) may be viewed in Information (page 5-29) in the units specified in UI Options (page 5-9). The MDA calculation is detailed in Minimum Detectable Activity (MDA) and High Background Criterion (page 6-16).

R_{Act} **Activity of Contamination (variable unit)** is the assessed activity of contamination, based upon the store efficiency and the net count rate.

Background Update

When the instrument is not monitoring a user, it will be monitoring background.

The background is monitored over one second check periods. The one second background counts are accumulated over a 10 second period and averaged to derive the Background Sample count rate (b) for each detector. Each 10 second background sample is screened for low beta counts and high alpha counts and compared with the stored average for the user defined Changing Background Level. When verified, the background sample is accumulated into a Rolling Average Background (B) for each detector. A minimum of ten valid 10 second Background Samples are accumulated for each detector before monitoring is permitted. Valid 10 second Background samples subsequent to the 10th are accumulated into the average and the oldest discarded to maintain a 100 second “Rolling Average” for each detector.

The Average Background is used in conjunction with other system parameters to calculate the Monitoring Time for each channel and hence screen for High Background conditions before monitoring can commence.

Because a contaminated user approaching the iPCM12 may affect the background of the instrument, background counts are pre-buffered for two seconds before being incorporated into the main background of the instrument. When a user is detected entering the instrument, these pre-buffered background counts are discarded.

To increase the availability of the iPCM12, the background update time (t_B) may be set to be dynamic by utilizing the Quick Background option (see Quick Background (page 6-18). When a new background count rate needs to be acquired, the instrument will only stay out of service for as long as it takes to acquire a background that results in a count time lower than the

Maximum Monitoring Time (T_{max}) set for the instrument. At this point, the instrument is capable of making measurements that meet the Probability of False Alarm and Detection criteria, albeit with a longer Actual Monitoring Time(T_{mon}) than would be possible with a longer Background Counting Time (t_B). This technique will allow monitoring to re-commence earlier and as more background counts are subsequently acquired, monitoring times will fall.

On the gamma option, because the FHT681 has an upper threshold that is typically configured as a "cosmic threshold", the gross counts are defined as counts in the energy band between the lower and upper thresholds. This is referred to as the gross counts window.

Changing Background

In relatively stable background conditions, 100 second "rolling average" accumulates an accurate background count. It is, however, slow to respond to sudden background disturbance and drift, making it necessary to screen each count before incorporating it into the rolling average. Consequently, to guard against inaccurate measurements and false alarms, the iPCM12 reads and checks the counts from each detector every second. A changing background condition exists if either of the following conditions are true:

Any one detector count shows a Mσ change from the stored average for that channel:

$$\left|\left[B_{av} - C_a\right]\right| \geq M\sqrt{B_{av}}$$

where B_{av} is the rolling average for any one detector.

C_a is the counts registered in the last one-second background update.

M is the Detector Changing Background variable (see Monitoring (page 5-14)). The default value for M is 7. It is not recommended that M should be set below 4.0σ.

In addition, for the gamma option, all nine detector counts show an Nσ change from their relevant stored averages in the same direction:

$$\left|\left[B_{av} - C_a\right]\right| \geq N\sqrt{B_{av}}$$

where B_{av} is the rolling average for any one detector.

C_a is the counts registered in the last one second background update.

N is the Gross Changing Background variable (see Monitoring (page 5-14)). It is not recommended that N should be set below 3.0σ.

The former expression detects gross changes in any single channel, while the latter guards against significant drift in all channels.

Calculation of the Monitoring Time (T_{cal})

After every successful background update, the average background for each channel is updated. The eight average backgrounds are then summed and a new monitoring time is re-calculated as follows:

$$C_{cps} = C_{Act}.E.Z_{Act}$$

where Act is one of the units below

Z_{Act} is the corresponding multiplier

Units	Unit Multiplier Z_{Act}
Bq	1
kBq	1000
Dpm	0.01666
pCi	0.037
nCi	37
µCi	3.7E4
mCi	3.7E7
Ci	3.7E10

T_{cal} found by solving:

$$C_{cps} = F\sqrt{\frac{B_{eff}}{t_B} + \frac{B_{eff}}{T_{cal}}} + P\sqrt{\frac{B_{eff}}{t_B} + \frac{B_{eff} + C_{cps}}{T_{cal}}} + \frac{1}{4}(F+P)^2\left(\frac{1}{t_B} + \frac{1}{T_{cal}}\right)$$

In practice, the software solves this expression using a numerical substitution for T_{cal} and an iterative binary search technique. The value of T_{cal} that provides the solution is then rounded up to the nearest whole second and compared to the user programmed minimum and maximum monitoring times.

The actual monitoring time (T_{mon}) used when monitoring is then set according to the following criteria:

$T_{mon} = T_{cal}$ when $T_{cal} > T_{min}$

$T_{mon} = T_{min}$ when $T_{cal} \leq T_{max}$

If $T_{cal} > T_{max}$ then a high background condition exists and monitoring is not possible. See Notes Regarding High Background (page 5-113).

Minimum Detectable Activity (MDA) and High Background Criterion

Once a mean background count rate has been calculated, the iPCM12 will be ready to monitor users; the Minimum Detectable Count Rate, also referred to as the detection limit (DL), is found by solving the following formula for DL:

Therefore $M_{Act} = \frac{DL}{Z_{Act}.E}$,

$$DL = F\sqrt{\frac{B_{eff}}{t_B} + \frac{B_{eff}}{T_{mon}}} + P\sqrt{\frac{B_{eff}}{t_B} + \frac{B_{eff} + DL}{T_{mon}}} + \frac{1}{4}(F+P)^2\left(\frac{1}{t_B} + \frac{1}{T_{mon}}\right)$$

where *Act* is the activity unit

Detectable Activity and Detection Limit may be viewed on the Information sub-menu (see Information (page 5-29)) and will be displayed in the units selected in UI Options (page 5-9).

NOTE: MDA may differ from the Alarm level because:
- T_{mon} is rounded up
- T_{min} may take effect

Changing Conditions

Changing conditions apply to beta and gamma measurements only.

During the monitoring cycle, the monitoring time is subdivided into time slices. Each sum of the count rates on all detectors in a slice is compared to the average count rate in the cycle up to that point.

Changing Conditions exist where the following formula is satisfied:

$$\left|\left[C_{av} - C_{sl}\right]\right| \geq N_{sl}\sqrt{C_{av}}$$

where C_{av} is the rolling average count rate within the monitoring cycle, up to the point of the check.

C_{sl} is the counts registered in the last time slice

N_{sl} is the Changing Conditions variable (see Monitoring (page 5-14)). It is not recommended that N_{sl} should be set below 3.0σ.

The first Changing Conditions check will take place after $2T_{sl}$ and then after every second within the monitoring cycle.

where T_{sl} is the Changing Conditions period (time slice) variable (see Monitoring (page 5-14)).

Contamination Alarm

After monitoring a user for the prescribed monitoring time (T_{mon}), the effective contamination alarm level (C_{effect}) is calculated as follows:

$$C_{effect} = C_{cps} - P\sqrt{\left(B_{eff}\left(\frac{1}{t_B} + \frac{1}{T_{MON}}\right) + \frac{C_{cps}}{T_{MON}}\right)}$$

The total system background count rate B_{eff} is then subtracted from the total system gross contamination count rate (C_{gross}), and the remaining (net) contamination count rate compared with the alarm level. So an alarm condition exists if:

$$\left(C_{gross} - B_{eff}\right) \geq C_{effect}$$

Zone Summation (if Required)

The alarm count rate for two zones summed together is the square root of the sum of the squares of the alarm count rate of the individual zones; therefore, the new summed alarm count rate, C_{sum}, is given by the following formula:

$$C_{sum} = \sqrt{\left(C_{effect,1}\right)^2 + \left(C_{effect,2}\right)^2}$$

Figure 16 shows the alpha beta sum zones.

Calculation of Activity and Associated Uncertainty

The system displays the level of radioactive contamination both on and in the user. The activity is displayed in multiples of the Alarm level, along with the zone that triggered the alarm on the body mimic. The derived activity in the appropriate activity units and its associated uncertainty are stored in the instrument database for later review. Only those numerical values that are in excess of the MDA are stored.

The activity is calculated using the following formula:

$$R_{Act} = Z_{Act} . \frac{C_{gross} - B_{eff}}{E_{mix}}$$

where R_{Act} refers to the activity in the selected unit.

For a single nuclide mix, $E_{mix} = E_{nuc}$. However, where the user has created a mix with multiple nuclides:

$$E_{mix} = \sum E_{nuc} . P_{nuc}$$

where E_{nuc} is the efficiency of the system to a specific nuclide

P_{nuc} is the proportion of the specific nuclide within the total mix.

The uncertainty of the activity measurement is calculated as follows:

$$\frac{R_{Act}.N_{conf}}{E_{mix}}\sqrt{\left(\frac{B_{eff}}{t_B}+\frac{C_{gross}}{T_{mon}}\right)}$$

where N_{conf} is the number of confidence levels.

Quickscan

Quickscan applies to beta and gamma measurements only.

Quickscan is a method used to identify, within the monitoring time T_{mon}, whether the user is either obviously contaminated or clear, referred to as "real-dirty" or "real-clean". Quickscan is enabled in Detection Options (page 5-17). It is only activated when $T_{mon}>T_{min}$. It will never be activated if the alpha monitoring time ($T_{mon\alpha}$) is greater than or equal to the beta and/or gamma monitoring time.

The Quickscan period T_Q is the time period after the beginning of the monitoring cycle, at which the first time slice check is undertaken. Subsequently, additional Quickscan checks will be undertaken at periods that are integer multiples of T_Q, e.g., $2T_Q$, $3T_Q$, until the end of the monitoring period. The Quickscan period is set in Operation (page 5-11).

If the Quickscan formula (refer to Thermo Fisher Scientific) is satisfied at any of the Quickscan checks, then the monitoring cycle will terminate with the appropriate clean or contaminated indication.

Quick Background

Quickscan applies to beta and gamma measurements only.

Quick background is a method that evaluates the shortest possible background monitoring time, while still satisfying the statistical criteria. Quick Background is enabled in Operation (page 5-11).

The formula used to evaluate the Calculated Monitoring Time (T_{cal}) is used. The system will re-evaluate the value of T_{cal} after every second of the background update, where the Background Update Time (t_B) is a variable. When the value of $T_{cal} < T_{max}$, then the system will return to service. Since the system acquires background counts at any time it is not in use, then the value of T_{cal} will reduce until a count rate from the previous 100 seconds has been acquired.

Co-60 Window Monitoring

The Co-60 window only applies to gamma measurements.

A specific alarm for ^{60}Co contamination may be set if enabled in Alarms (page 5-19). This alarm is based upon monitoring only those high energy photons which cannot be associated with radionuclides that emit lower energy photons, such as ^{137}Cs. Therefore, it is also possible for other high energy photon emitters to be monitored using the ^{60}Co window.

The method of assessment of background count rates and contamination level applies to the ^{60}Co window channel in the same way as for gross alarms described in this section. However, both the background count rate B_{Co} and the efficiency E_{Co}, are considerably lower than for the gross sum channel.

Residual Contamination Level

After a measurement resulting in an Alarm condition, a Residual Contamination Count (RCC) may be taken, if enabled in Operation (page 5-11). A count equal to the monitoring time (T_{mon}) is enforced.

Residual Contamination is assumed to exist where the following formula is satisfied:

$$\left(C_{RCC} - B_{sum}\right) \geq N_{RCC}\sqrt{\left(\frac{B_{sum}}{T_{mon}}\right)}$$

where C_{RCC} is the average count rate during the Residual Contamination Count period.

N_{RCC} is the RCC threshold variable (see Monitoring (page 5-14)).

The default setting for N_{RCC} is 7.0σ and should never be set to a less than the sum of the probabilities of detection and false alarm (P+F).

In the event of residual contamination being detected, the iPCM12 will enter an "Out of Service" state and monitoring will not be possible (see Notes Regarding Residual Contamination Check (page 5-109)). Intervention by a password holder will be required to terminate the fault status (see Instrument Contaminated (page 5-110)).

Automatic Calculation of Calibration Monitoring Time

The Calibration technique (see Calibration Menu (page 5-38)) uses flash (10 second) background and source counts to automatically calculate the count time for the user. The Calibration Accuracy and the associated confidence level are set in Calibration (page 5-16)).

The count confidence level has a default setting of 3σ (99.7%), which is a generally accepted Confidence level that produces acceptable count times.

Then Calibration Count Time,

where N_{conf} = 3 (Count Confidence Level of 99.7%)

n = Flash source + background Count (cps)

b = Flash Background Count (cps)

A = Calibration Accuracy (ratio e.g. 5% = 0.05)

The calculated count time is rounded up to the nearest whole second and T is limited to 10,000 seconds.

$$T = N_{conf}^2 \frac{\left(n + \sqrt{nb}\right)}{A^2 (n-b)^2} (Sec's)$$

Calculation of Alarm Levels

This section describes the Calculation of Alarm Levels for Parameter data entry. Alarm levels may be set in terms of activity or count rate (cps).

Assumptions

To calculate the Alarm Levels in terms of count rate, the following assumptions are made:

The surface emission rate of the clothing or body is assumed to be half of the activity. This will only be true for a perfect source with zero backscatter and self absorption. In practice the operator may wish to make allowances for these effects when setting the count rate alarm levels (especially where alpha and low level beta contamination is being monitored).

The following formula is used to calculate the Alarm Countrate, C, for alpha, beta, and gamma Contamination.

$$C = \tfrac{1}{2} A.a.E_{nuc}$$

where *A* is the alarm Activity per unit area required to give an alarm, typically in UK:

40 Bq/cm^2	(2400 dpm/cm^2)	for γ
4 Bq/cm^2	(240 dpm/cm^2)	for B
0.4 Bq/cm^2	(24 dpm/cm^2)	for α

In USA, a typical beta activity alarm limit is 5000 dpm, averaged over 100 cm^2, i.e., 0.83 Bq/cm^2.

a is the area over which the Contamination activity is averaged, normally 300 cm^2 for both sides of the Hand and sole of the foot and 100 cm^2 for Body (including the head).

E_{nuc} is detector efficiency to nuclide of interest.

For Hand and Feet alpha and beta detectors, this is expressed in terms of S.E.R. (2π). Body average efficiencies for Beta and Gamma body detectors are expressed in terms of activity (4π), therefore:

$$C = A.a.E_{nuc}$$

Examples:

^{60}Co Beta on Hands (standard grille)

If A = 4 Bq/cm^2

a = 150cm^2 (assumed area of one side of one hand)

E_{nuc} = 31% detector efficiency to ^{60}Co (2π)

then C = ½ × 4 × 150 × 0.31 = 93 cps

^{241}Am Alpha on Hands (standard grille)

If A = 0.4 Bq/cm^2 (2π)

a = 150cm^2 (assumed area of one side of one hand)

E_{nuc} = 28 detector efficiency to ^{241}Am (2π)

then C = ½ × 0.4 × 150 × 0.28 = 8.4 cps

Alpha and ßeta Feet values are calculated similarly (using a as 300 cm^2).

^{60}Co Beta on Feet

If A = 4 Bq/cm^2

a = 300cm^2 (assumed area of sole of one foot)

E_{nuc} = 35% Detector Efficiency ^{60}Co (2π)

then C = ½ × 4 × 300 × 0.30 = 210 cps

^{241}Am Alpha on Feet

If A = 0.4 Bq/cm^2

a = 300cm^2 (assumed area of sole of one foot)

E_{nuc} = 32% detector efficiency to ^{241}Am (2π)

then C = ½ × 0.4 × 300 × 0.32 = 19 cps

^{60}Co Beta on Body (unsummed) – standard grille – UK limit

If A = 4 Bq/cm^2

a = 100cm^2 (over body)

E_{nuc} = 5.5% Body Average Efficiency 4π

then C = 4 × 100 × 0.055 = 22 cps

^{60}Co Beta on Body (unsummed) – standard grille – US limit

If A = 0.83 Bq/cm^2

a = 100cm^2 (over body)

E_{nuc} = 5.5% Body Average Efficiency 4π

then C = 0.83 × 100 × 0.055 = 4.6 cps

^{60}Co Gamma (Gross) on Body (unsummed)

If $A = 40$ Bq/cm^2

$a = 100$cm^2 (over body)

E_{nuc} = 10% Body Average Efficiency 4π

then $C = 40 \times 100 \times 0.1$ = 400 cps

Probability – Sigma and %

Table 1 Probability - Sigma and %

Sigma	Probability
0.0	50.00%
0.1	53.98%
0.2	57.93%
0.3	61.79%
0.4	65.54%
0.5	69.15%
0.6	72.57%
0.7	75.80%
0.8	78.81%
0.9	81.59%
1.0	84.13%
1.1	86.43%
1.2	88.49%
1.3	90.32%
1.4	91.92%
1.5	93.32%
1.6	94.52%
1.7	95.54%
1.8	96.41%
1.9	97.13%
2.0	97.72%
2.1	98.21%
2.2	98.61%
2.3	98.93%
2.4	99.18%
2.5	99.38%
2.6	99.53%
2.7	99.65%
2.8	99.74%
2.9	99.81%
3.0	99.87%
3.1	99.90%
3.2	99.93%
3.3	99.95%
3.4	99.966%

Sigma	Probability
3.5	99.977%
3.6	99.984%
3.7	99.989%
3.8	99.993%
3.9	99.995%
4.0	99.997%

NOTE: This probability refers to either the Probability of Detection or the Probability of NOT triggering a False Alarm. These probabilities are calculated and displayed in Detection Options (page 5-17).

Setting of Alarm Levels, False Alarm Rates, and Probabilities

Contamination Alarm Levels and associated averaging areas are generally driven by legislation. However, programming of statistical detection certainty (Probability of Detection) and False Alarm rates are often local site decisions that impact on the Monitoring Time and equipment 'credibility' with the users. High false alarm rates quickly lower user confidence in the integrity of the measurement, while too stringent statistical requirements extend monitoring times, which results in low 'throughput' and queues of frustrated users.

The following discussion is intended to draw attention to the issues involved, their consequences, and practical solutions. These scenarios are similar for most common nuclide types and energies, but particularly acute in the case of low-energy betas.

A statistical demonstration program, available from Thermo Fisher Scientific, provides numerical solutions to given conditions and also gives a graphical representation, which is a valuable aid to understanding the effects and interactions of parameters.

Detector efficiency and averaging area are the variables that affect the Alarm set point count rate (C), above background. For beta emitters:

C = {Alarm activity per unit area x averaging area x detection efficiency (4π)}

Using the ^{60}Co efficiency values from Specification (page 3-1) and the U.S. alarm limit:

^{60}Co on Body:	$C = (0.83\ Bq/cm^2 \times 100cm^2 \times 5.5\%$ (4π))	= 4.6 cps

Consider the graphical representation in Figure 17. The ^{60}C body alarm level of 4.6 cps is the center of the right-hand distribution at 9.6 cps (4.6 cps above the average 5 cps background).

Alpha and Beta on Hands & Feet

The hands and feet are in defined positions and in contact with the detector surface, so it is perfectly legitimate to use contact efficiencies when calculating alarm levels – values used should be to *activity (4π)* or ½ Surface Emission Rate as above.

Beta on Body

The use of body positioning systems and the geometry of the instrument force most parts of the body to be in contact with a detector at some point of the measurement cycle. However there will be some parts of the body where there is a small distance to the closest detector. For the purpose of this example, we use Body Average Efficiencies based on a closest approach to a body detector of 5 cm (as defined in IEC 61098). However, this model is pessimistic for the sculpted geometry of the iPCM12.

Hands, Feet, and Body (which includes the head) each have separate Alarm Levels; however, for any given nuclide energy, the body alarm level will always be most stringent, dictating the monitoring time and thus user throughput. Monitoring time will be significantly increased in higher backgrounds.

Alpha on Body

The alpha Alarm Level is generally used as 0.4 Bq/cm². With a body grille contact efficiency of around 15% *(4π)*, the body alarm level will be:

Alarm Level Count-rate (C)	= (0.4 Bq/cm² × 100 cm² × 0.15)	= 6 cps

Since the alpha background count is generally low, typically 0.025 cps and theoretically no more than 0.1 cps, the alarm level is generally easily achievable and the beta body alarm level dictates the Monitoring Time (T).

In instances where alarm levels up to an order of magnitude lower (0.04 Bq/cm²) are required, the alarm count rate (C) will be around 0.6 cps. Although this level is theoretically achievable, in practice ***only four*** Radon events reaching the detector will cause a false alarm!

The calculations in the instrument are based on a Gaussian model, which is valid for gamma and beta measurements. However, the model used has variations, which makes it a closer approximation of the Poisson distribution at the very low count rates associated with alpha measurements.

Effect of Probability of False Alarm (F)

This is the probability of a false alarm occurring due to natural background fluctuations.

The Background (B) for each detector is continuously monitored on a 100-second rolling average – represented by the sharply defined left-hand peak in Figure 13. It is centered about the average background (B) and is a relatively tight distribution because it is measured over 100 seconds, statistically accurately known, and thus has a relatively small effect on monitoring time.

However, statistical background fluctuations during the relatively short (often less than 10 seconds) monitoring time are significant and, unless corrected for, are likely to cause false alarms. In Figure 13 the wider left-hand peak represents the distribution about the 5 cps average background (B) in the monitoring time (T).

False alarm correction is achieved by the probability of false alarm factor (F) operating on the stored average background (B). This effectively produces a modified value of the background for use in the statistical calculations, beyond which the probability of natural fluctuation is known to be acceptably small. In Figure 13 the modified background used in the statistical calculations is represented by the left-hand vertical line. In this instance, the stored background average B of 5 cps is corrected to ~9.8 cps for use in calculation of the optimum monitoring time to give a false alarm rate of at least the value of F entered. (The stored average background value of (B) for each detector is retained, unaltered by calculations).

The false alarm rate is important but should, however, be kept as low as practicable, because high frequency of false positives quickly degrades instrument credibility and user confidence. In practice, 1 in 1,000 false alarms is widely accepted for personnel monitoring. Because a false positive on *only one* of the detectors, in either half of the measurement cycle gives a false alarm, the value of F used must reflect the total number of detectors in the whole measurement. Depending upon detector options fitted, for a maximum of 60 detectors a value of 4.2 sigma ensures a maximum of 1 in 1,000 false alarms for the whole system.

Use of the “Auto-recount” option in the Software may be useful. This will automatically require the user to re-monitor in the event of an alarm announcing only the final measurement result. This significantly reduces the probability of two consecutive false alarms due to background variation and avoids unnecessary “recordable incidents”. It also has the benefit of automatically confirming real alarms.

Effect of Probability of Detection (PoD)

This is the probability that *exactly* one Alarm Level of Contamination will be detected.

The rate of detecting *exactly* one Alarm Level of emissions is, on average, 50% or 0 sigma. In Figure 13, the right-hand peak represents the distribution about the Contamination alarm level (C) during the Monitoring Time (T). In this instance the alarm level (C) is set 4.6 cps above the average Background (B) of 5 cps.

A higher detection rate may be desired and can be achieved by modifying the contamination alarm level set point by the probability of detection (P). This effectively 'backs off' (reduces) the alarm level, creating a lower contamination count 'triggering threshold', represented by the right-hand vertical line in Figure 13. In this instance, the alarm level count-rate is adjusted to ~3.2 cps above the background (B) to achieve 1.65 sigma (95%) probability of detecting ***exactly one*** alarm level of contamination.

Increased probability of detection (P), effectively reduces the Alarm Level, causing a corresponding increase in the monitoring time (T), to achieve the false alarm rate (F).

When measuring low energy beta emitters and alpha emitters, small body movements will drastically affect the sensitivity - a movement of a few centimeters may change the sensitivity by up to an order of magnitude. This variation would be far more significant than stringent selection of probability of detection.

Monitoring Time (T)

Judicious setting of the Probability of False Alarm and Probability of Detection, as described previously, will keep monitoring times to a minimum and maintain personnel throughput.

Calculation of the Minimum Monitoring Time

Consider Figure 17. As discussed earlier, the left-hand vertical line represents effective background count adjusted to achieve the required measurement False alarm rate (F) (in this instance 1 in 1,000) in the monitoring time (T). Also as discussed earlier, the right-hand vertical line is the alarm level count-rate adjusted to achieve the required Probability (P) of detecting *exactly one* alarm level of contamination (in this instance 1.65 sigma {95%}) in the monitoring time (T).

The 'positive separation' between the modified background and alarm counts indicates that the set of conditions presented in Figure 13 can be achieved in a 15 second monitoring time with an "Operational Margin". This operational margin would

therefore accommodate a more stringent set of parameters, which in practice is likely to be an increase in the background (B). However, for the set of conditions presented, the user is being monitored *beyond* the precision and certainty required, thus effectively 'wasting time' – which reduces throughput.

Therefore, the iPCM12 software continuously adjusts the monitoring time (T) to the minimum required to achieve the statistical requirements as the background changes. This is reflected in Figure 18, which shows that the monitoring requirements can be achieved in less than 11 s. Note that the iPCM12 rounds the monitoring time up to the nearest whole second. The point where the two vertical lines *just meet* is the absolute limit of detection – effectively the alarm trigger point above the average background.

High Background

Any change in background (B) will result in a monitoring time adjustment. If a background increase requires the monitoring time to exceed the iPCM12 user programmed *maximum* (T_{max}), a "high background" condition exists. In graphical terms, the two vertical lines have c*rossed over* into a 'negative separation' condition and the monitoring time can no longer be increased to restore the balance.

In this situation, the maximum monitoring time (T_{max}) must be increased, the Alarm count must be increased, or the statistical requirements (P and/or F) must be relaxed for the instrument to resume operation. This is a "non-fatal" condition from which the iPCM12 will automatically recover if the background (B) falls to an acceptable level.

Operational Margin

In Figure 17 the 'positive separation' between the modified background and alarm counts indicates that an operational margin exists for the given parameters.

Figure 18 shows the monitoring time T adjusted to 11 seconds, ***just*** balancing the statistical equation with variables F, P, B, and C – the positive separation is approaching zero. If T_{max} is greater than T, then an operational margin exists and allows T to increase dynamically to compensate for any variable changes – usually background.

If, however, T increases to the point where it is verging on T_{max}, the system is at the absolute statistically allowable limit – effectively balanced on a "statistical knife edge" and there is no "Operational Margin" to compensate for change in any quantity. A ***fractional*** increase in the background (B) from any one detector will force the IPM into a "High background" state.

In practice, programming T_{max} to **just** balance the statistical parameters in the prevailing background condition leaves no

'operational margin' and should be avoided. It will cause the iPCM12 to switch between normal operation and 'High Background' with the slightest background drift from any detector, effectively rendering it unusable.

Having decided on statistical requirements, always program T_{max} to cope with the worst case background condition expected. The iPCM12 will dynamically adjust T to achieve the required statistical certainty in the minimum monitoring time to maximize throughput and minimizes HP/guardian intervention.

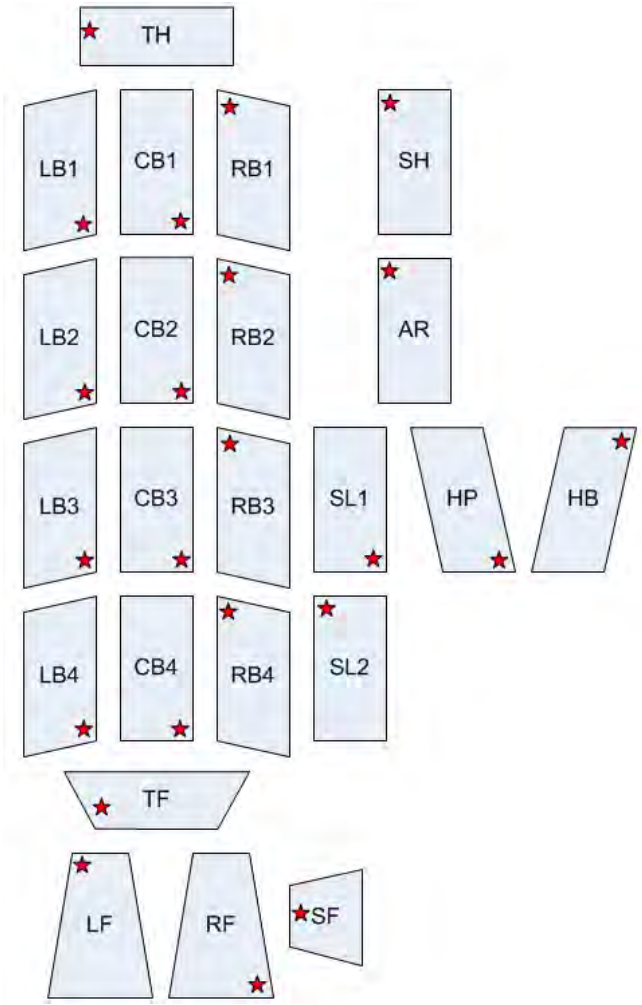
User Throughput

With fairly short monitoring times, such as 3 to 5 seconds each-way, user throughput largely depends upon ease of entry and exit, familiarity, and ease of use of the monitor. A five-second each way monitoring time will allow familiar users to pass through the iPCM12 within 20 seconds; i.e., three or more personnel per minute.

Detector Naming

Gas Flow Detector Naming

The gas flow detector map is shown below:



Mnemonic	Detector
TH	Top of Head
LB1	Left Body Array Level 1 (Top)
CB1	Center Body Array Level 1 (Top)
RB1	Right Body Array Level 1 (Top)
SH	Side of Head / Shoulder
LB2	Left Body Array Level 2
CB2	Center Body Array Level 2
RB2	Right Body Array Level 2
AR	Upper Arm
LB3	Left Body Array Level 3
CB3	Center Body Array Level 3

Mnemonic	Detector
RB3	Right Body Array Level 3
SL1	Side of Leg Upper
LB2	Left Body Array Level 4 (Bottom)
CB4	Center Body Array Level 4 (Bottom)
RB4	Right Body Array Level 4 (Bottom)
SL4	Side of Leg Lower
HP	Hand Palm
HB	Hand Back
TF	Top of Foot
LF	Left Foot Sole
RF	Right Foot Sole
SF	Side of Foot

Adjacent Horizontal Quadrants Left & Centre	
LB1A	CB1A
LB1B	CB1B
LB1C	CB1C
LB1D	CB1D
LB2A	CB2A
LB2B	CB2B
LB2C	CB2C
LB2D	CB2D
LB3A	CB3A
LB3B	CB3B
LB3C	CB3C
LB3D	CB3D
LB4A	CB4A
LB4B	CB4B
LB4C	CB4C
LB4D	CB4D

Adjacent Horizontal Quadrants Centre & Right	
CB1A	RB1A
CB1B	RB1B
CB1C	RB1C
CB1D	RB1D
CB2A	RB2A
CB2B	RB2B
CB2C	RB2C
CB2D	RB2D
CB3A	RB3A
CB3B	RB3B
CB3C	RB3C
CB3D	RB3D
CB4A	RB4A
CB4B	RB4B
CB4C	RB4C
CB4D	RB4D

Adjacent Horizontal Quadrants, Right and Side	
RB1A	SHA
RB1B	SHB
RB1C	SHC
RB1D	SHD
RB2A	ARA
RB2B	ARB
RB2C	ARC
RB2D	ARD
RB3A	SL1A
RB3B	SL1B
RB3C	SL1C
RB3D	SL1D
RB4A	SL2A
RB4B	SL2B
RB4C	SL2C
RB4D	SL2D

Adjacent Side with Opposing detectors on next step	
SHA	LB1A-2
SHB	LB1B-2
SHC	LB1C-2
SHD	LB1D-2
ARA	LB2A-2
ARB	LB2B-2
ARC	LB2C-2
ARD	LB2D-2
SL1A	LB3A-2
SL1B	LB3B-2
SL1C	LB3C-2
SL1D	LB3D-2
SL2A	LB4A-2
SL2B	LB4B-2
SL2C	LB4C-2
SL2D	LB4D-2

Adjacent Horizontal	
LB1A-2	CB1A-2
LB1B-2	CB1B-2
LB1C-2	CB1C-2
LB1D-2	CB1D-2
LB2A-2	CB2A-2
LB2B-2	CB2B-2
LB2C-2	CB2C-2
LB2D-2	CB2D-2
LB3A-2	CB3A-2
LB3B-2	CB3B-2
LB3C-2	CB3C-2
LB3D-2	CB3D-2
LB4A-2	CB4A-2
LB4B-2	CB4B-2
LB4C-2	CB4C-2
LB4D-2	CB4D-2

Adjacent Horizontal	
CB1A-2	RB1A-2
CB1B-2	RB1B-2
CB1C-2	RB1C-2
CB1D-2	RB1D-2
CB2A-2	RB2A-2
CB2B-2	RB2B-2
CB2C-2	RB2C-2
CB2D-2	RB2D-2
CB3A-2	RB3A-2
CB3B-2	RB3B-2
CB3C-2	RB3C-2
CB3D-2	RB3D-2
CB4A-2	RB4A-2
CB4B-2	RB4B-2
CB4C-2	RB4C-2
CB4D-2	RB4D-2

Adjacent Horizontal	
RB1A-2	SHA-2
RB1B-2	SHB-2
RB1C-2	SHC-2
RB1D-2	SHD-2
RB2A-2	ARA-2
RB2B-2	ARB-2
RB2C-2	ARC-2
RB2D-2	ARD-2
RB3A-2	SL1A-2
RB3B-2	SL1B-2
RB3C-2	SL1C-2
RB3D-2	SL1D-2
RB4A-2	SL2A-2
RB4B-2	SL2B-2
RB4C-2	SL2C-2
RB4D-2	SL2D-2

SHA-2	LB1A
SHB-2	LB1B
SHC-2	LB1C
SHD-2	LB1D
ARA-2	LB2A
ARB-2	LB2B
ARC-2	LB2C
ARD-2	LB2D
SL1A-2	LB3A
SL1B-2	LB3B
SL1C-2	LB3C
SL1D-2	LB3D
SL2A-2	LB4A
SL2B-2	LB4B
SL2C-2	LB4C
SL2D-2	LB4D

Vertical Quadrants Left	
LB1A	LB1B
LB1B	LB1C
LB1C	LB1D
LB1D	LB2A
LB2A	LB2B
LB2B	LB2C
LB2C	LB2D
LB2D	LB3A
LB3A	LB3B
LB3B	LB3C
LB3C	LB3D
LB3D	LB4A
LB4A	LB4B
LB4B	LB4C
LB4C	LB4D

Vertical Quadrants Centre	
CB1A	CB1B
CB1B	CB1C
CB1C	CB1D
CB1D	CB2A
CB2A	CB2B
CB2B	CB2C
CB2C	CB2D
CB2D	CB3A
CB3A	CB3B
CB3B	CB3C
CB3C	CB3D
CB3D	CB4A
CB4A	CB4B
CB4B	CB4C
CB4C	CB4D

Vertical Quadrants Right	
RB1A	RB1B
RB1B	RB1C
RB1C	RB1D
RB1D	RB2A
RB2A	RB2B
RB2B	RB2C
RB2C	RB2D
RB2D	RB3A
RB3A	RB3B
RB3B	RB3C
RB3C	RB3D
RB3D	RB4A
RB4A	RB4B
RB4B	RB4C
RB4C	RB4D

Vertical Quadrants Sid	
SHA	SHB
SHB	SHC
SHC	SHD
SHD	ARA
ARA	ARB
ARB	ARC
ARC	ARD
ARD	SL1A
SL1A	SL1B
SL1B	SL1C
SL1C	SL1D
SL1D	SL2A
SL2A	SL2B
SL2B	SL2C
SL2C	SL2D

Vertical Quadrants Left	
LB1A-2	LB1B-2
LB1B-2	LB1C-2
LB1C-2	LB1D-2
LB1D-2	LB2A-2
LB2A-2	LB2B-2
LB2B-2	LB2C-2
LB2C-2	LB2D-2
LB2D-2	LB3A-2
LB3A-2	LB3B-2
LB3B-2	LB3C-2
LB3C-2	LB3D-2
LB3D-2	LB4A-2
LB4A-2	LB4B-2
LB4B-2	LB4C-2
LB4C-2	LB4D-2

Vertical Quadrants Centre	
CB1A-2	CB1B-2
CB1B-2	CB1C-2
CB1C-2	CB1D-2
CB1D-2	CB2A-2
CB2A-2	CB2B-2
CB2B-2	CB2C-2
CB2C-2	CB2D-2
CB2D-2	CB3A-2
CB3A-2	CB3B-2
CB3B-2	CB3C-2
CB3C-2	CB3D-2
CB3D-2	CB4A-2
CB4A-2	CB4B-2
CB4B-2	CB4C-2
CB4C-2	CB4D-2

Vertical Quadrants Right	
RB1A-2	RB1B-2
RB1B-2	RB1C-2
RB1C-2	RB1D-2
RB1D-2	RB2A-2
RB2A-2	RB2B-2
RB2B-2	RB2C-2
RB2C-2	RB2D-2
RB2D-2	RB3A-2
RB3A-2	RB3B-2
RB3B-2	RB3C-2
RB3C-2	RB3D-2
RB3D-2	RB4A-2
RB4A-2	RB4B-2
RB4B-2	RB4C-2
RB4C-2	RB4D-2

Vertical Quadrants Sid	
SHA-2	SHB-2
SHB-2	SHC-2
SHC-2	SHD-2
SHD-2	ARA-2
ARA-2	ARB-2
ARB-2	ARC-2
ARC-2	ARD-2
ARD-2	SL1A-2
SL1A-2	SL1B-2
SL1B-2	SL1C-2
SL1C-2	SL1D-2
SL1D-2	SL2A-2
SL2A-2	SL2B-2
SL2B-2	SL2C-2
SL2C-2	SL2D-2

Right Hand Palm			
HPA	HPB	HPC	HPD

Left Hand Palm			
HPA-2	HPB-2	HPC-2	HPD-2

Top Left Toe	
TTA	TTB

Full Toe Left			
TTA	TTB	LFA	LFB

Sole Left - step 1			
LFA	LFB	LFC	LFD

Sole Left - step 2			
RFA-2	RFB-2	RFC-2	RFD-2

Side Foot Left			
SFA-2	SFB-2	SFC-2	SFD

Total Head Step 1			
THA	THB	THC	THD

Left Top Head			
THA	THB	THC-2	THD-2

Right Hand Back			
HBA	HBB	HBC	HBD

HBA-2	HBB-2	HBC-2	HBD-2

Top Right Toe	
TTC	TTD

Full Toe Right			
TTC	TTD	RFA	RFB

Sole Right - step 1			
RFA	RFB	RFC	RFD

Sole Right - step 2			
LFA-2	LFB-2	LFC-2	LFD-2

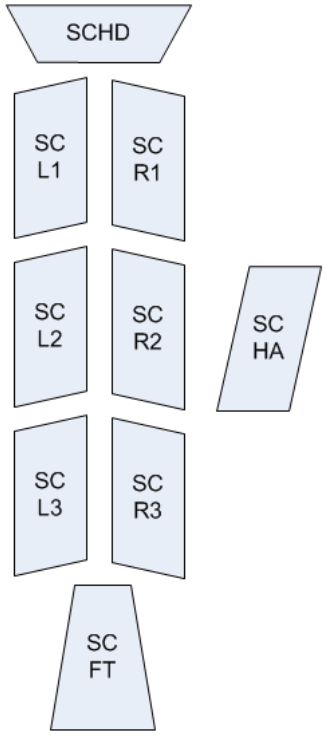
Side Foot Right			
SFA	SFB	SFC	SFD

Total Head Step 2			
THA-2	THB-2	THC-2	THD-2

Right Top Head			
THA-2	THB-2	THC	THD

Figure 16 Gas Detector Sum Zones

Scintillation Detector Naming



Mnemonic	Detector
SCHD	Scintillation Head
SCL1	Scintillation Left Body 1
SCL2	Scintillation Left Body 2
SCL3	Scintillation Left Body 3
SCR1	Scintillation Right Body 1
SCR2	Scintillation Right Body 2
SCR3	Scintillation Right Body 3
SCHA	Scintillation Hand
SCFT	Scintillation Foot

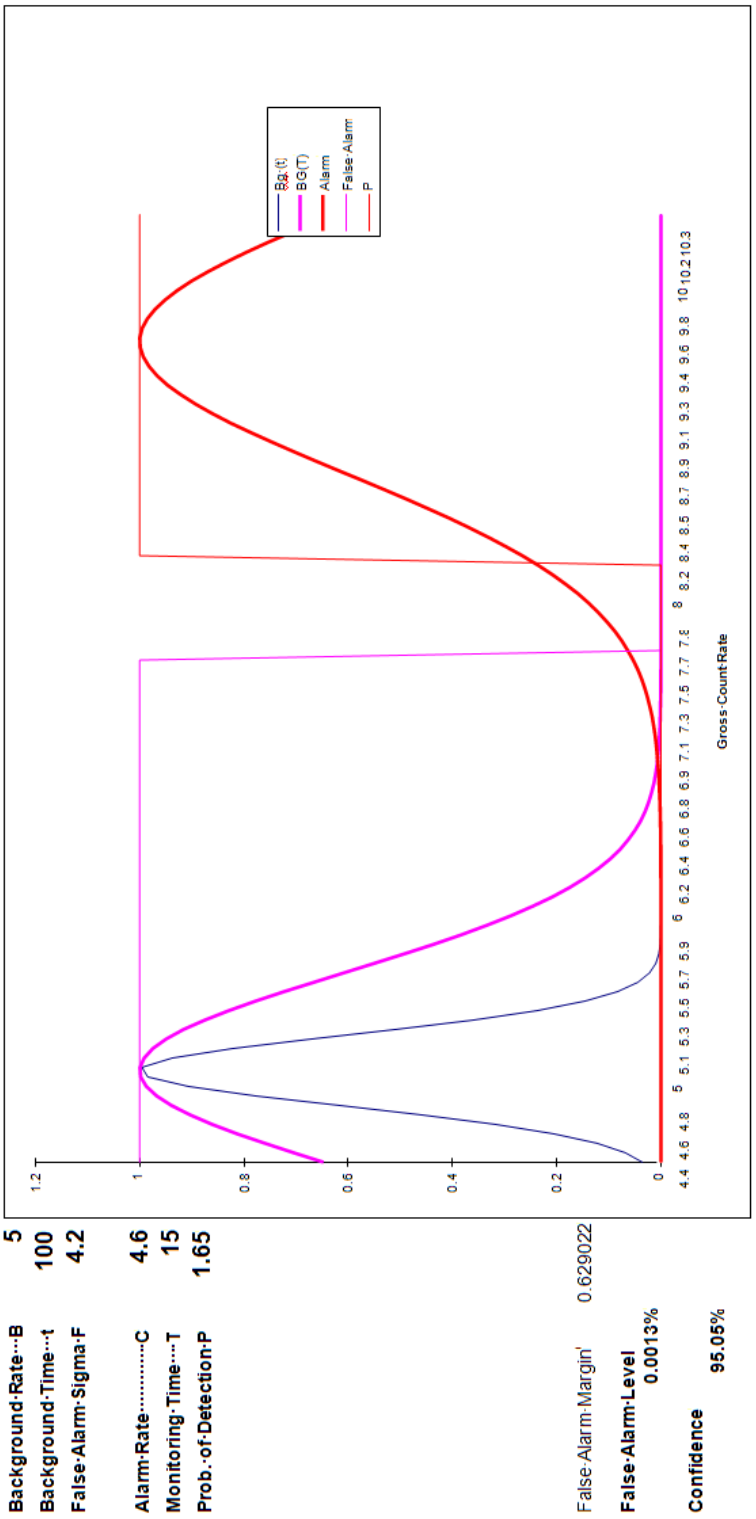


Figure 17 Monitoring Statistics showing "Operational Margin"

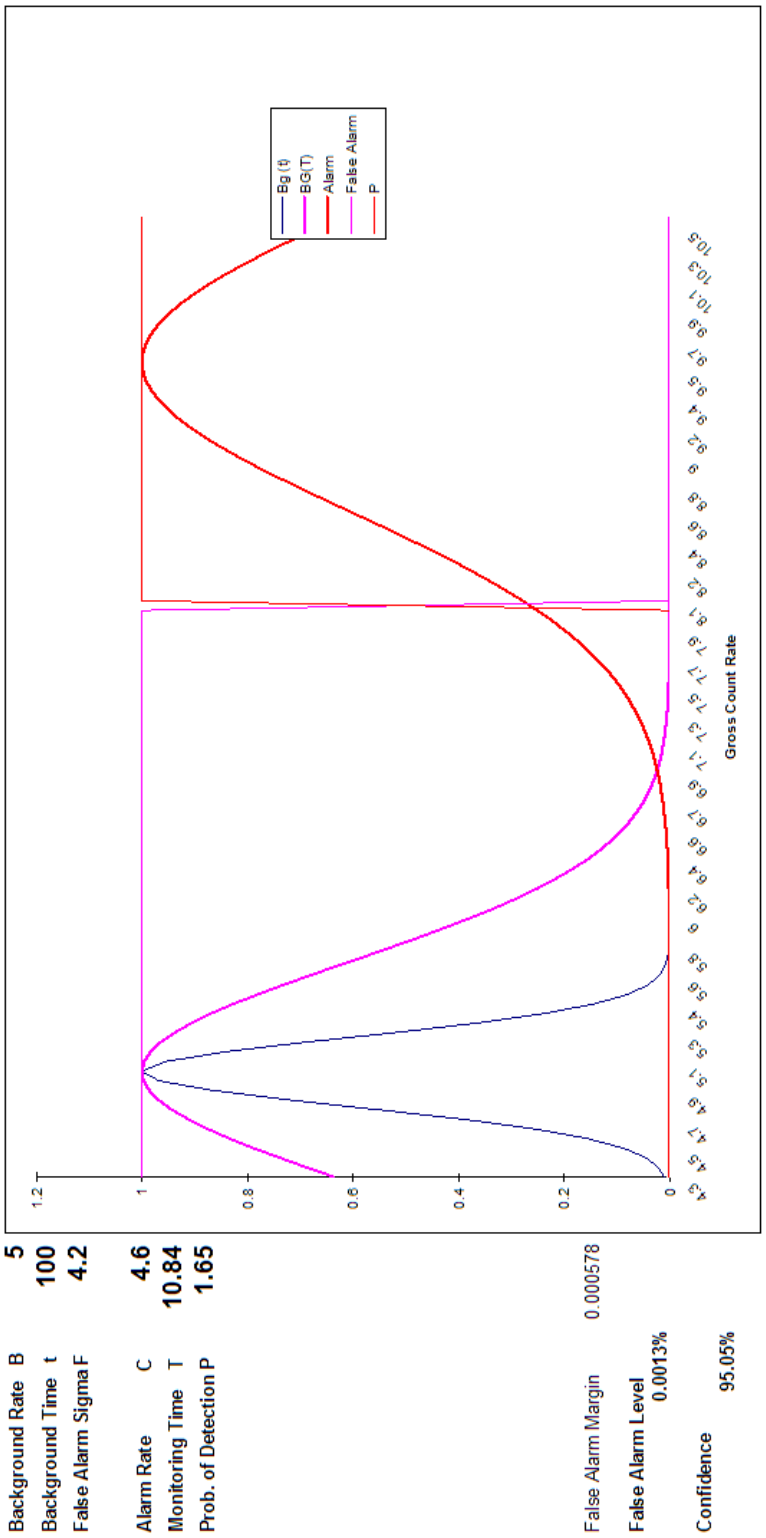


Figure 18 Monitoring Statistics showing "Minimum Monitoring Time"

Chapter 7 Technical Description – Circuitry

Description (page 2-1) provides a general background to the following description and should be read before proceeding.

Introduction

This section outlines the operation and function of all the major electronic assemblies that comprise the iPCM12. Description of all assemblies is restricted to general operation and specification because detailed circuit operation may be the subject of design confidentiality. The main circuit boards described here include:

5703A	Battery Controller	Controls and monitors charging / discharging of battery
5704A	Quad Amplifier Board	Proportional gas amplifier with four channels
5709A	Gas control Board	Monitors and controls flow of gas through system
5711A	Guidance Display	Provides guidance to user for correct positioning and time for monitoring
5712A	ETX Processor Board	Main processor board
5713A	HV Generator Board	Generates the HV for the Gas proportional counters
5714B	DC/DC Converter Board	Produces 5 and +/-12V for system from unregulated (battery backed) DC power

Reference to General Assembly D92591 and family tree D92425 shows the interconnections between the main iPCM12A modules:

- Electronic display chassis assembly D92520/A (see Electronic Display Chassis D92520/A (page 7-2)

  The processing center for the iPCM12 includes the power management circuitry.

- Guidance display assemblies 5711A and 5672A (see 5711A Guidance Display and 5672A LED Cluster Indicator (page 7-7)

This includes LED cluster indicators.

- Sensor assemblies and interconnections

Gas flow sensor data is produced by flow sensors on the 5709A gas control board that is connected via the auxiliary X-channel2 Bus cabling. Positioning sensors are powered and monitored via adjacent 5704A detector electronics and data is communicated via the primary X-channel2 cabling.

- Detector assemblies 5710A (see 5710A Gas Flow Counter and 5704A Quad Amplifier (page 7-6))

Each rectangular gas flow detector has four discrete detector regions, each wired to the quad amp board mounted on the rear of the detector housing.

- Touch screen color graphics LCD assembly D92583/A is mounted on the rear of the Electronics display chassis, making the display easily visible to the user standing inside the iPCM12 (see LCD Display and Controller I/F and Backlight Inverter Module (Assembly D92583/A) (page 7-9)).

Reference to General assembly D92777 (for closed booth iPCM12B and iPCM12C door variants only) shows additional interconnections between the following modules:

- Power door GPIO interface 5707A (see iPCM12C Option - GPIO Controller Card 5707A (page 7-9))
- Barrier Mechanism (see iPCM12C Option - GPIO Controller Card 5707A (page 7-9))
- Swing door interfacing

Items only applicable to scintillation versions of iPCM12B and iPCM12C when fitted with gamma detector option kit AE0222A are:

- Scintillation HV amplifier FHT681 (see iPCM12B or iPCM12C with Gamma Kit Including FHT681 Scintillation HV and Amplifier (page 7-8))
- Body scintillator 5717A (see Scintillation Gamma Detectors Type 5708A and 5717A (page 2-14))
- Head, foot and hand scintillation detector 5708A (see Scintillation Gamma Detectors Type 5708A and 5717A (page 2-14))

Electronic Display Chassis D92520/A

The majority of the electronics is contained on board this sub-structure allowing easy removal for servicing.

The assembly contains the following modules:

- X-channel controller board 5712A (see ETX Controller Board – Type 5712A (page 7-3))
- Hard disk drive A92083/A
- Gas flow control chassis including 5709A gas flow board (see 5709A Gas Control Board (page 7-6))
- DC-DC converter 5714B (see 5714B DC/DC Converter Board (page 7-7))
- HV Generator module 5713A (see 5713A HV Generator Board (page 7-7))
- 150W PSU module
- Battery control board 5703A (see Battery Controller Board Type 5703A (page 7-5))
- Quad USB outputs

ETX Controller Board – Type 5712A

This controller board comprises all the interface buffers and connections necessary to communicate between all peripherals and the proprietary on-board plug-in the ETX processor.

The assembly has the following facilities used by the system:

- 1.5GHz Pentium-M processor
- 512 megabytes of RAM
- Dual RS232 Serial communication interface
- Real time clock supported by an off-board Lithium battery
  The RTC provides microprocessor access to year, month, day, hour, minute, seconds. It also provides several interrupt periods from one year down to 0.01 seconds.
- Quad USB hub
- Single Ethernet interface
- LCD and CRT drivers
- Dual IDE ports
- Flash Card interface
- Audio synthesizer

Summary of 5712A Functions

Function	Source	Destination	Comments
VGA/CRT	SK3		Display interface available for diagnostics
LCD drive	PL6	Touch screen	LVDS cable
LED control	PL8, 9	5711A and 5672A	Visual indicators
Backlight	PL7	Touch screen	Fixed intensity
Touch control	PL2, 4	Touch screen	RS232 interface
USB power controllers	SK4, 11, 15, 16	Lower LCD paneling	Provides independent power sources with current limiting for USB peripherals
External Network	SK201	Upper mainframe	
Primary X-channel2 bus	SK1,6,7,14	All 5704 gas amplifiers	RS422 using RJ45 cables
Auxiliary X-channel2 bus	SK8,15	5709A Gas Control Board 5713A HV Generator	RS422 using RJ45 cables
X-channel bus	PL5, PL12	5703A Battery Controller FHT681 Scintillation Amplifiers	RS422
Loudspeaker	PL1	Upper mainframe	Loudspeaker drive from the on-board (ETX) sound generator
Power Switching	PL10	DC/DC converter	5714B
Fan Control	PL13		Not used
Primary IDE	SK10	Electronic chassis	44 pin /2.5" Disk Interface
Secondary IDE	PL15	Compact flash	40 pin /CD ROM Interface
Power	PL20	DC/DC converter	5714B

COM1 Ports

RS232 voltage levels on PL2 COM port1are as follows:

Label	Connection PL2	Function
TXD	5	Transmit Data
RX-EXT	3	Receive Data
DTR	7	Data Terminal Ready
RTS	4	Ready to Send
DCD	1	Data Carrier Detected
CTS	6	Clear to Send
RI	8	Ring Indicator
DSR	2	Data Set Ready

Battery Controller Board Type 5703A

This is an X-channel device that enables the operating system to monitor the charging process and remotely shut down the load. (iPCM12s will be fitted with 5720A controllers in the future.)

The Battery Controller Board, type 5703A, controls the DC voltage output of a power converter unit (PL4) between the range +11.2 V to +15.6 V in order to maintain the integrity of the +12 V 15 Ah Lead Acid Battery (PL3), over the operating temperature range (temperature sensor on PL1).

The 5703A has the ability to switch the load (PL6) ON/OFF, as directed by the operator, while continuing to charge the battery. Current and voltage monitoring (IC100/101) and control circuitry (IC4) always ensure sufficient power is made available to power the iPCM12 (even when the battery is exhausted) from the primary power source.

The transfer to battery is automatic; however, the load will be removed when the battery terminal voltage falls bellow +10.5 V. This circuit is required to prevent the battery being damaged by being deeply discharged. Hysteresis is built into this circuit to prevent oscillations. It does not allow the battery to re-connect as soon as its terminal voltage recovers slightly as a result of having the load removed from its terminals.

The user is informed of a pending shut-down in order that any data can be saved.

A key switch is connected to the 5703A or (5720A, when fitted) for manually switching the power ON/OFF to the load.

Keyswitch Operation

The keyswitch performs two operations.

Primarily, it allows the instrument to be switched ON if the mains supply exists and/or the battery contains sufficient charge. This is achieved by turning and holding the key clockwise for at least two seconds.

Secondarily, the instrument can be switched OFF should the operating software fail to carry out the "Shut-down" task by turning and holding the key clockwise for at least ten seconds.

5710A Gas Flow Counter and 5704A Quad Amplifier

The 5710A gas counter comprises four separately wired rectangular detector zones within an aluminum body and an aluminized conductive mylar window.

A 5704A quad amplifier is mounted on the rear of the 5710A. The single input HV has filtered HV connections to each of four anode terminals within the counter. Four separate amplifiers buffer and shape the alpha and beta pulses, then pass these to discriminators. High/low beta and alpha pulses are processed via IC13 prior to X-channel interfacing at network connectors PL1 and PL2.

PL5 provides connections for initial IC13 and IC14 flash memory device programming.

Optical sensor input and supply at +5V are provided via PL3 and PL4 for the user positioning sensors on the iPCM12.

5709A Gas Control Board

The 5709A is mounted on the gas flow chassis located above the ETX processor board. The X-channel processor IC5 accepts data from the adjacent inlet flow and exhaust flow sensors and controls up to two gas solenoids: Inlet and Exhaust.

Under normal usage with Argon/Methane gas, the inlet solenoid is activated. Under gas purge conditions (controlled via the iPCM12 menu), the inlet and exhaust solenoids are activated, thus bypassing the gas restrictor tubing.

PL7 provides connections for initial IC5 and IC6 flash memory device programming.

PL2 and PL3 provide X-channel interfacing.

5713A HV Generator Board

IC2 DAC calibration circuits and HV clock from the on-board processor IC13 provide a step-up transformer input to generate the anode voltage for the gas flow detectors. Under software control a Cockroft-Walton style voltage tripler circuit boosts the generated output HV up to 4kV. Two filtered HV outputs are provided for use within the iPCM12.

PL1 and PL2 provide X-channel interfacing.

PL5 provides connections for initial IC13 and IC14 flash memory device programming.

5714B DC/DC Converter Board

Regulated and filtered power lines of +5V, +12V, and -12V are produced via three DC/DC converters mounted on this board. These outputs are routed to the adjacent ETX 5712A board.

5711A Guidance Display and 5672A LED Cluster Indicator

The upper plinth is fitted with a 5672A LED cluster board with five indicators showing the real time status of the iPCM12:

GREEN	Ready/Clear
WHITE	Count
YELLOW	Recount
RED	Alarm
BLUE	Out of service

Unbuffered drivers are provided at PL9 on the 5712A control board.

The 5711A guidance display board has a two digit LED indicator to show the countdown on measurements. It also has two indicators showing the real time user status of the iPCM12:

ORANGE	Position body facing detectors
WHITE	Position with back to detectors

Buffered drivers are provided at PL8 on the 5712A board.

iPCM12B or iPCM12C with Gamma Kit Including FHT681 Scintillation HV and Amplifier

The Dual-Channel Scintillation HV and Amplifier board FHT681 provides the high voltages for two scintillation detectors. It also receives charge pulses from two detectors, amplifies them, and discriminates between five energy levels. Independent counter values (five for each gamma channel) are generated every 100 ms and stored in a five-second buffer. In addition to that, one second values are built from the 100 ms values. All these values can be polled from the serial interface.

HV and Amplifier Connections

The HV sections are designed to provide independently adjustable anode voltages for two scintillation detectors with working voltage ranges between 500 V to 1400 V.

The setting of high voltages and thresholds is done via the serial interface.

The 1st, 3rd, and 4th counters for each channel form Cobalt coincidence pulses that are available on OUT1 and OUT2 connectors.

The card has six connectors.

PMT1 and PMT2 Scintillation detectors are connected via MHV connectors

OUT1 and OUT2 Coincident outputs are on BNC connectors

X15 and X16 These connectors provide power supplies to the board and X-Channel Interface:

X15 and X16	SIGNAL
1	EARTH
2	0V
3	RX-
4	TX-
5	Signal Ground
6	TX+
7	+5V
8	RX+
9	+5V

Mains Power Module (Assembly 702947KJ)

The mains power supply is a proprietary high-frequency switched mode 150 Watt converter. The power module can accept a mains input of 85 V to 264 V, 47 Hz to 63 Hz; the output is between 12 V and 18 V at a maximum of 8.33 A. The actual output voltage is controlled remotely by the 5703A (or 5720A if fitted).

The power supply is capable of charging the battery at a maximum rate of 3.3 A, up to +40°C. This module contains AC Mains and dangerous DC switching voltages. It should not be operated with the protective cover removed or the mains ground (earth) conductor disconnected. It is not user serviceable and should be returned to Thermo Fisher's Service department for repair.

LCD Display and Controller I/F and Backlight Inverter Module (Assembly D92583/A)

The LCD module is fitted with an integral Cold Cathode Fluorescent (CCFL) backlight (which is replaceable if found faulty). The backlight is driven from a proprietary inverter, mounted in a small screened box within the display. The inverter generates dangerous high voltages and RF interference frequencies and should not be operated outside the box or with the display lid removed.

The LCD is controlled via a proprietary serial interface device also mounted in a small screened box within the display.

Four USB sockets are provided on the base of the assembly.

Neither the display nor the backlight inverter nor the controller are user serviceable and should be returned to the Thermo Fisher Service department for repair.

iPCM12C Option - GPIO Controller Card 5707A

This is an X-Channel device that controls and monitors ingress and egress PFCs (doors, barriers, or turnstiles).

The board is split into two logical halves to control two PFCs, with I/Os 0,1,2,3 allocated to PFC0 and I/Os 4,5,6,7 allocated to PFC 1.

Input / Output	Connection	Bi-Fold Door	Barrier	Manual Door	Turnstile	Swing Door
IP0 / 4	PL08 / PL09 pins 1 and 2	Doors Closed	Barrier Open Limit SW	Door Closed	Transit Detected	Door Closed
IP1 / 5	PL08 / PL09 pins 3 and 4	Doors Opened	Barrier Closed Limit SW.	Lock Tellback		Lock Tellback
IP2 / 6	PL08 / PL09 pins 5 and 6	Panic		Panic	Panic	Panic
IP3 / 7	PL08 / PL09 pins 7 and 8	Open Request	Open Request	Open Request	Open Request	Open Request
Relay 1	PL4 / PL5 pins 1,2,3	Door Open	Pin2 Barrier Drive -ve	Door Unlock	Forward Unlock	Door Unlock
Relay 2	PL4 / PL5 pins 4,5,6		Pin5 Barrier Drive +ve		Freewheel	Power Assist Open
Relay 3	PL4 / PL5 pins 7,8,9				Reverse Unlock	
INTER-LOCK	PL13 pins 4 and 5	Emergency Open	Emergency Open	Emergency Open	Emergency Open	Emergency Open
POWER	PL1 pin 1 and PL1 pin 2					
X-channel/ A/ FHT681s	PL6/10 way IDC					

General Electromagnetic Compatibility (EMC) Considerations

The overall construction is designed to minimize the effects of mains and airborne interference and emissions.

It is, therefore, vital that the construction standard is maintained at all times, particularly when replacing parts and during servicing.

Earthing is particularly important for continued EMC (and Safety) performance. ‘Hard’ earthing of the mains inlet/filter assembly and LCD display tail, the HV/Amplifier FHT681 screening can, and the frame earth are particularly important. Refer to the relevant Servicing instructions for details.

The instrument should only be operated with all earthing connections securely made and all screening covers fitted.

Chapter 8 Routine Checks

This section describes the routine checks required to ensure the correct operation of the iPCM12. Most mechanical and electronic failures, if they occur, will become apparent during normal operation and do not require checking. Therefore, they are not included in this section.

Mechanical Checks

iPCM12 Mounting Arrangement

During calibration, or more frequently if required, check any mechanical structure on which the iPCM12 may be mounted. The iPCM12C with the gamma option kit includes 1 cm and 2 cm areas of shadow lead shielding and is very heavy. Mounting arrangements including the base spreader plate should be inspected for signs of deterioration, instability, or any other factor that may affect safety of operation or maintenance. If any such defect is suspected, the iPCM12 should be withdrawn from service and safely removed using a suitable forklift and the integral fork lifting facilities provided. The mounting should be repaired and made safe before replacing the iPCM12.

Electrical Checks

Battery Charge State

During calibration, check the general condition of the battery. To do this, turn the iPCM12 ON by rotating the key-switch on the front panel to the ON position. Remove the mains power cord. Unlock and open the right hand side access panel and locate PL5 on controller card 5703A (or 5720A, if fitted). Connect a suitable Voltmeter, set to the DC volts range, directly across the terminals of PL5 (pins 1 and 6). Ensure that the "load" battery voltage is greater than 12 volts (assuming the battery has previously been charged). If the battery voltage is low, consult Trouble Shooting (Operational) (page 11-26).

Alternatively, the battery voltage and load can be monitored from within the application (see Battery (page 5-21) for more information).

NOTE: Only qualified personnel should operate the iPCM12 with the mains connected and the access panel open. Make sure all the warnings given at the front of this manual are heeded.

Display Checks

It may be necessary at some time (due to replacement of a Touch Screen or Touch Controller) to re-calibrate the touch screen. This is an Administration function and the facility would be accessed outside of the application program.

EMC & Safety Earthing Checks

Periodically, and after Servicing, ensure that all Earth connections are fitted and tight to ensure continued EMC performance and User Safety. These checks should include the screws and washers securing the mains inlet/filter assembly in the top chassis, all connections to the central earth point (CEP), and the connection to the main and side frames.

Also check that all screening covers are fitted and all fixings tightly secured.

Periodic Source Checks

During calibration, after repairs, or once a year, the detection efficiency of the iPCM12 should be checked using a Calibration check as described in Cal Check (page 5-39). To perform these checks, small area sources of the nuclides that the iPCM12 is required to detect should be used. A stable background is essential for an accurate result. The calibration check will be performed to an accuracy defined by Default Calibration Accuracy (%).

The overall Efficiency calibration factor should be within ±10% of the existing programmed value. Should the results be outside these limits, the iPCM12 operational parameters require revision (see Setting Up Procedure (page 9-1)).

Calibration procedures are described in Calibration Procedure (page 10-1).

Carry out a regular source check after a 100 sec background update.

Regular Source Checks

Daily or weekly source checks are advisable, using a Calibration check as described in Cal Check (page 5-39).

For detector calibration, the check source needs to be placed in calibration positions coinciding with the geometric center of all detectors. Typically ^{36}Cl or ^{99}Tc extended area sources are used for beta checking and ^{241}Am is used for alpha checking.

An alternative is to undertake an Alarm Check, where a source of activity marginally greater than alarm level setting should be

held against each detector in turn. Each detector should alarm within the typical monitoring time.

Cleaning Instructions

WARNING: ENSURE THE MAINS SUPPLY IS ISOLATED BEFORE CLEANING.

The display can be wiped clean with a dry cloth. Smudges may require the application of the Screen cleaner provided when the instrument was delivered.

The cubical should be cleaned using a mild detergent.

Make sure the equipment is completely dry before re-connecting the supply.

Dust and accumulated lint can be cleaned from the detectors using a weak vacuum cleaner. Use care to ensure the detectors are not damaged by the vacuum cleaner.

Chapter 9 Setting up Procedure

Initial Setting up for Use

General

After the initial installation and before switching on the iPCM12, read Operating Instructions (page 5-1). Connect the mains lead to the iPCM12 and turn the keyswitch clockwise until the unit switches On (a click is heard after about 1-2 seconds) and then release it (see Keyswitch Operation (page 7-6)).

Initialization

The iPCM12 will power up and load up the Windows XP Embedded operating system, followed by the iPCM12 application. During this time, the *Thermo Scientific* banner displays (see below).

Once the application has loaded, the application will initialize (see Start Up Checks (page 5-87)). The system will automatically pass into the User Mode. In this mode, the user will not have access to any operational parameters. In order to set up the instrument the user requires a security dongle, which should be placed in the USB port of the iPCM12. When this dongle is in place, the touch screen is activated, and the user will have access to the Administrator Mode (page 5-1).

Setting Passwords

There are three user levels: Technician, Health Physicist and Thermo Fisher. The lowest level is *Technician* and allows the user to view some parameters and undertake calibration checks. The *Health Physicist* level gives access to all parameters that are used for calibration and setup of the instrument. The top level *Thermo Fisher* is reserved for the expert user because it gives access to specialized calibration settings that fundamentally affect the performance of the instrument; these

should only be set at the Thermo Fisher factory or by a Service Engineer. See Passwords (page 5-80) for details regarding the default passwords. The menu options that are available to each user levels are summarized in Menu Roles (page 5-7).

Passwords (page 5-80) show how the user can change the password. Both the *Thermo Fisher* and the *Health Physicist* passwords protect the security of the operational parameters and hence the integrity of the measurement. Therefore these passwords should remain confidential; their use restricted, and above all should not be readily obvious to potential "hackers".

Each user level should have a unique password and under no circumstances should all three levels be assigned the same password.

Setting the Operational Parameters

At this point, it is strongly recommended that the following User Programmable Operational Parameters are checked and reset by the Health Physicist before allowing normal monitoring to proceed. As noted below, it may be helpful to consult the configuration report to view the parameter settings established during the factory test and calibration. A configuration printout is also normally provided with the initial documentation and iPCM12 manual.

Core parameters are noted here:-

Activity units: Bq, Ci, DPM

See Set-Up|UI Options (page 5-9) for more information.

Quick Scan Period for β , γ
Out of service recovery interval

See Set-Up|Operation (page 5-11) for more information.

Low Background Limit (β, γ)
Max Zero Count Time (α)
High Background Limit (α, β, γ)
Minimum Monitoring Time
Maximum Monitoring Time
Measurement Confidence
All Detector Changing Background
Detector Changing Background
Changing Conditions
Changing Conditions Period
α Background Stability Factor
β Background Stability Factor

See Set-Up |Monitoring (page 5-14)for more information.

Calibration Required Interval
Calibration Warn Period
Calibration Confidence – *typically 2σ (~95%)*

See Set-Up|Calibration (page 5-16) for more information.

Probability of False Alarm – *typically 3.1σ*
Probability of Detection – *typically 1.65σ*
α , β , γ , sumzones

See Set-up|Detection Options (page 5-17) for more information.

Calibration stream selection
α , β , γ , ^{60}Co Alarms

See Set-Up|Alarms (page 5-19) for more information.

Resetting the above parameters will guarantee the integrity of measurements. It is also important to reset the time and date (see System|Setup (page 5-79)) because these are used when checking the calibration due dates, and also by the Data option.

A listing of all the parameters is available by selecting Configuration Report (page 5-68). This report should be either printed or saved to USB memory stick when the instrument is first set up and again when significant changes of configuration are undertaken.

The iPCM12 will be delivered optimized with a valid HV Scan and optimum operating voltages stored. If the HV Scan needs to undertaken for any reason, follow the procedure described in Detector HV Selection (page 9-4).

The details of the current and previous calibrations are stored to a backup compact flash. These backups take place automatically after every calibration, and when requested by the User. It is recommended that the backup be undertaken after every voltage scan and calibration. This backup may be retrieved if for any reason the hard drive on the instrument needs replacement.

Selection of Detector Operating Parameters

The following sections assume that the instrument is set to the factory defaults. **NOTE:** For all variants of iPCM12, the gas flow detector working voltages are the same (depending on the gas medium used), whereas gamma detector working voltages are specifically set for each PM tube/scintillator.

Detector HV Selection

The Test and Performance Certificate supplied with each instrument lists the recommended High Voltage settings for each detector for the optimum detection. HV Scan (page 5-46) describes the setting of the detector HVs.

If it is required to ascertain the optimum operating voltages by measurement, e.g. due to new detectors, the procedure described in Derivation of the Optimum Operating Voltage (page 9-4) should be followed.

Derivation of the Optimum Operating Voltage

The iPCM12 is designed to detect activities down to release levels and otherwise 'as low as reasonably achievable - ALARA'. However, the iPCM12 is also very linear in response, so a wide range of source activities may be used for set-up and calibration.

For the **gas flow** detectors, typical beta and alpha extended area sources for contact measurements will be required around 0.1μCi (~4kBq) with a calibrated SER – surface emission rate - e.g., 2000β/sec and 2000α/sec.

Depending upon energy / detector efficiency, for **gamma** scintillation detectors source activity should typically be in the 2 μCi (~80kBq) to 6 μCi (~200 kBq) range, and in any case not more than 10 μCi (370 kBq). Long count times will be required for small sources to maintain statistical accuracy against adverse background influences.

Performing the HV Scan

NOTE: For all the measurements performed below, all sources of radiation other than those used for the specific test, should be removed from the immediate area in order to minimize the effect of background fluctuations. All counts read from the detectors are corrected to compensate for the amplifier "dead time".

With the iPCM12 and surrounding area free of sources, enter the Administrator Mode (page 5-1)as 'Health Physicist'. From the function tabs on the left side of the screen select the 'Calibration' option. Then from the tabs along the top of the screen, select 'HV Scan'.

There is a choice between displaying the gas flow HVscan (α / β) or, if fitted, the gamma HVscan (γ). In that case, there will be a choice between performing a 'New Scan' and viewing the 'Last Scan'. Press the 'New Scan' button.

The new screen allows for the setting of the scan parameters Start, Stop, and Step voltages as well as the counting time.

The recommended values for these parameters are:

For **gas flow** detectors -

Start = 1400 volts

Stop = 2000 volts

Step = 20 volts

Time = 10 seconds

For **gamma** scintillation detectors -

Start = 600 volts

Stop = 1100 volts

Step = 5 volts

Time = 10 seconds

NOTE: Short voltage steps are required for the gamma scan in order to make the location of the optimum operating voltage easier to determine. Using the recommended values, this process will take approximately one hour to complete.

Once the parameters have been set and the 'Start' button has been pressed, a series of onscreen instructions displays to step the user through the scan process.

NOTE: The scan can be aborted at any time by pressing the 'Abort' button. The background scan is performed on all detectors simultaneously.

For the **gas flow** detectors, it is not obligatory to carry out HV scans unless the gas medium has been changed. This is because the characteristics of gas flow detectors have the same optimum working point, which is typical of type. An HV scan for one gas flow detector is included in the factory testing to ensure the correct operation of the detectors. One HV scan for a beta source in contact with the detector grille, plus one HV scan for an alpha source in contact with the detector grille is normally sufficient to establish the correct gas flow working voltage for the whole instrument. This can be repeated for other detectors if deemed necessary.

Typically, for the recommended P7.5 gas (7.5% Methane CH_4, 92.5% Argon), the optimum EHT working point for 5710A gas flow detectors is 1775V.

For the **gamma** detectors, the first step is to perform a background scan. This is followed by a scan with a ^{137}Cs source. The user has the option of selecting which detectors to scan.

The quickest method is to place the source in the center of the portal at a location nominally 100 cm above the treadplate and

spaced 5 cm from the face of the central detector and scan all the detectors simultaneously.

An alternative method is to scan the detectors in three phases.

Phase 1 - Place the source at a height of 50 cm above the treadplate and select the lower two gamma body detectors plus the foot detector for scanning.

Phase 2 - Place the source at a height of 100 cm above the treadplate and select the central two gamma detectors plus the hand detector for scanning.

Phase 3 - Place the source at a height of 150 cm above the treadplate and select the upper two gamma body detectors plus the overhead detector and side-of-head detector (if fitted) for scanning.

Another alternative method is to scan each detector individually, with the source in close proximity to the center of each detector, i.e., nominally three inches (7.5 cm).

Thermo Fisher believes the optimum method is the three phase method, because this process ensures the source is in close proximity to the detectors being scanned, while minimizing overall test time.

On completion of the scan, the user is given the option of saving the data by pressing the ‘Save Scan’ button. This data, along with its description, can be retrieved via the ‘Data’ tab (see HV Scan (page 5-46)). Once the ‘Save’ button has been pressed, the display changes to show graphs of the scans.

Determining Gamma Detectors Operating Voltage for Mid-high Energy Nuclides

There are two methods for determining the optimum operating voltage for the gamma detectors: either using the NBR method, which optimizes the pulse height threshold settings to obtain energy information; or the "classic" way, by reviewing the Figure of Merit at each voltage setting. The recommended method is the NBR method, which typically will also provide an operating voltage that satisfies the Figure of Merit criteria. The NBR method must be used if the ^{60}Co window or low energy indications are enabled. The NBR method requires the use of a ^{137}Cs calibration source for voltage optimization.

NBR Method

When the graph of the voltage plots displays, press the detector on the screen mimic and the respective graph for that detector, which will expand to fill the screen. Select the NBR button; a ratio against operating voltage graph displays. The optimum operating voltage is that which has a T1/T2 ratio of between 30 and 35. In order to find this, press the “Table” button; the data displays. From the table, identify the operating voltage that has the correct T1/T2. If you have to interpolate between two

voltages, assume a linear change. Enter this value into the "HV Setting" box and then press the "Back" button.

The value below the graph will now have a **Gold** background to it. This background color highlights that the value has been changed, but not yet saved. When all operating voltages have been set, press the "Apply Settings" button to save these values.

NOTE: The `Back' button **must** be pressed in order to access the other functions.

Figure of Merit (FOM) Method for Gamma Scintillation Detectors

NOTE: The following procedure tends to be iterative in nature and is included as a guide only. Different operational requirements and background conditions may necessitate a different choice of operating point. The final choice should be at the discretion of the senior Health Physicist.

When the gamma (γ) graphs display, select the 'Gross Counting' option and then press the respective graph for a detector, which will expand to fill the screen. Pressing 'Table' will show the actual FOM and S^2/B values – note that S^2/B is proportional to FOM and is included for those users who prefer this quantity.

For mid and high energies, FOM 'peak' is usually evident from the data. Determine the maximum value of FOM for each detector - **as a starting point**. If no clear peak is visible or several peaks exist, select a starting FOM value corresponding to a background value (B) similar to that of the other detectors. Select the detector operating point as follows:

Test 1. Each background count does not differ by more than 30% from the mean value of all detectors.

Test 2. When the source to detector distance is the same, calculate the Mean Source Counts (Sm) for all detectors. The value of the net source counts (S) for each detector does not differ by more than 25% from the mean value of (Sm) for all.

If any detector exceeds any of these limits, alter the relevant HV by 10 V and check that the FOM is not significantly different than the original. A total adjustment of 75 V is permissible.

This is a rough guide and individual circumstances may demand wider variations.

Test 3. When the background and source values are satisfactory, calculate the 4π gamma detector efficiencies at the chosen HV setting. Calculate the overall system efficiency, which should be within ±20% of the 4π efficiencies noted below. These are measured

at the contact face of the gas flow detector grille located nearest to the gamma detector:

Nuclide	Upper body(γ)	Lower body(γ)	Hand(γ)	Foot(γ)	Head(γ)
^{137}**Cs** (662 keV)	9.0%	5.9%	3.4%	8.4%	17.4%
^{60}**Co** (1.2 MeV)	21.5%	12.5%	7.7%	15.8%	25.0%

If the overall system efficiency or any individual detector efficiency is too low (or too high), consider the efficiency values at the next HV step - review the background Criteria in Tests (1) & (2) and the Source Criteria in Test (3). Repeat this process if necessary.

NOTE: The MDA is proportional to the square root of the Background – lower background improves (reduces) the MDA. Therefore 'squeezing' a few extra source counts at the expense of a significant background increase would be detrimental.

Refer also to iPCM12 Specification (page 3-1) and Technical Description - Physics (page 6-1) for BAE details and operational alarm level settings.

Setting the Gas Flow Detector High Voltage

Select the Gas Flow Detector Voltage parameter from the main menu, and set the correct working voltage to the nominal figures shown. This varies with the gas mixture in use, the recommended working voltages are indicated in Specification (page 3-1).

Typically, for the recommended gas mixture P7.5 (7.5% Methane CH_4, 92.5% Argon), the working voltage is 1775V. Details are shown on the configuration print-out for the instrument at the time of manufacture.

NOTE: The voltage quoted here is valid within ± 300 m (1000 ft) of sea level. The working voltage may reduce by as much as 25 V/300 m (1000 ft) above sea level.

Gas System

Gas Supply

The Gas supply should be regulated 3 to 5 psi or 14 to 35 KPa or 0.15 to 0.35 Bar. Gas is Argon/Methane at mixture between 90%/10% (P10) and 95%/5% (P5). 92.5%/7.5% (P7.5) is recommended. Ensure that the Gas flow detector HV settings are correct for the gas mixture as noted in the previous section.

Leakage Checks

The gas inlet purge and flow rates are set using needle valves on the gas control chassis. Both needle valves need to be adjusted to bring the gas system fully into service. As a default, the gas controller can only deliver gas at the reduced "normal" gas flow rate, even if the purge rate has not been set. This avoids any possibility that the purge rate is inadvertently set at maximum, so if an iPCM12 is switched on without any gas adjustment there is no gas detector damage due to overpressure. The gas controller board holds the exhaust solenoid open and the restrictor is bypassed indefinitely.

Select Diagnosis and Gas Flow sub-menu to view the current gas status. With the Purge Mode selected on screen, adjust the **manual needle valve** labeled "PURGE" on the gas chassis to set an INPUT PURGE flow of 200 cc/min ±5%. In this Mode the restrictor circuit is bypassed by solenoid. Note that turning the valve clockwise reduces the flow rate. Allow the gas system to stabilize for 10 minutes.

With Normal Mode selected on screen, the iPCM12 gas circuit reverts to normal flow rates. Adjust the **manual needle valve** labeled "NORMAL" on the gas chassis to set an INPUT NORMAL flow of 25 cc/min ±20%. After allowing the gas system to stabilize for 20 minutes, the inlet and outlet flow meters should indicate identical flow rates. In practice, however, small discrepancies due to calibration errors, pressure changes and very small leaks are likely to exist. An outlet flow rate up to 10% less than the inlet flow rate is acceptable. A larger discrepancy indicates a leak, which may be isolated by "linking-out" sections of the gas circuit, referring to Gas Schematic D92591 sheet 4, or ideally by using a gas "sniffer".

The hot spare detector may be utilized to minimize instrument downtime when a detector is changed.

NOTE: The thin detector windows allow a rapid rise in the gas temperature and hence the volume as the gas moves through the system. This can cause the outlet flowmeter reading to appear greater than the inlet flow until the gas system has stabilized.

Gas Flow Parameters

Normal mode High and Low gas flow limits plus purge limits and fault ratios are established by referring to the Setup menu and the Gas Flow sub-menu.

Typical parameter settings are:

Normal Mode Low Limit	0 cc/min
Normal Mode High Limit	75 cc/min
Purge Mode Low Limit	50 cc/min
Leak Ratio	50%
Averaging Period	5 secs
Maximum Stabilization Period	60 mins

The real-time operational gas status may be observed by referring to the Diagnostic menu and the Gas Flow sub-menu. The flow rates are shown as a simplified bargraph, which is updated in accordance with the average period set.

Purge and Operational Flow

Before the iPCM12 will function reliably, all of the air must be purged from the gas flow detectors. A rapid purge of between 200 and 300 cc/min for at least four hours is preferable; alternatively, a minimum purge of 12 hours (overnight) at 50 cc/min may be used.

Proceed as follows:

1. Via the HP menu access, select the Diagnosis menu and Gas Flow submenu. Observe that the INLET PURGE flow is now set at about 200 cc/min, although the restrictor is bypassed, it will take about 10 minutes before the EXHAUST flow reaches this level. Note that a gas leak fault will be indicated temporarily.
2. Wait 10 minutes and check that the outlet flow is > 50 cc/min.
3. If this is not the case, check for leaks and/or blockages.
4. Perform 10 second Test Counts at half hour intervals until all gas flow detectors show similar and consistent count rates:
5. A normal count rate will be approximately 4 to 5 cps in a low background (equivalent to ~ 50 to 60 cps/μSv/h for body, hand, and foot detectors).
6. Set the Mode switch to Normal, which places the restrictor in circuit.

NOTE: The typical Inlet flow rate will be between 20 and 25 cc/min for leak-free beta only systems. The flow rate may be set to 50 cc/min for more “robust” operation and peak alpha efficiency.

Chapter 10 Calibration Procedure

This section deals in detail with primary system calibration. It includes background, source and efficiency checks on individual detectors to confirm detector balance as well as overall system efficiency. Primary system calibration by the Health Physicist is usually necessary only on initial installation and on a periodic audit basis. More frequent overall system calibration checks can be quickly carried out by Technician user level using the "Cal Check" facility (see Cal Check (page 5-39)). For more information regarding the user roles, see Foreword (page xv) and Menu Roles (page 5-7).

NOTE: Throughout this section examples are given in Bq. However, by first selecting DPM from the Options Menu (see UI Options (page 5-9)) as the operating units, all values may be entered in these units. Of course, the equations remain unchanged, though care must be taken to ensure that the units are consistent.

Calibration Validity

The iPCM12 is capable of undertaking a calibration validity check. This check will evaluate the number of days between the last valid (PASS) calibration check. If this number of days exceeds the maximum acceptable recalibration interval, then the iPCM12 will put itself "Out of Service" (see Out of Service (page 5-112)).

To define the period between calibrations checks, set the "Calibration Required Interval" parameter in Calibration (page 5-16).

Equipment Required

Gas Flow Detectors

1. A radioactive source of known nuclide and activity, which is found within typical contamination levels to be monitored. The iPCM12 is designed to monitor radioactivity on the surface of the body to levels less than 83 (5000 dpm) for beta and 17 Bq (1000 dpm) for alpha. Planar sources of surface area less than or equal to 100 cm^2 and activities between 400 Bq and 6 kBq are used to calibrate detectors.
2. In order to speed up the calibration process, a two-source magnetic jig (Thermo Fisher part no. AE0246 or AE0247) that attaches to the detector grille may be used. This allows calibration of two detection zones, on a single detector, at the same time.

Gamma Scintillation Detectors

1. A radioactive source of known nuclide and activity, which is found within typical contamination levels to be monitored. The gamma option is designed to monitor radioactivity on the surface of the body to levels less than 400 Bq (11 nCi) of ^{60}Co, and quantify significantly larger activities, up to and in excess of 5 MBq (130 µCi). Because the iPCM12C has a very linear response to activity, any source of activity between 185 kBq (5 µCi) to 350 kBq (9.5 µCi) range may be used. Long count times will be required for small sources to maintain statistical accuracy against adverse background influences.
2. A source holder, to securely retain the source for positioning within the portal.

Preparation for Calibration

First the user must open the Calibration Menu (page 5-38). Select HV Scan (page 5-46) and ensure that the detector HVs are set correctly for the Calibrating isotope. If these are not known, they must be determined as described in Detector HV Selection (page 9-4) before proceeding with the calibration. The iPCM12 is then ready for calibration.

Calibration

Ensure the background is stable and any calibration sources are well away from the iPCM12.

1. Ensure the portal is empty and the unit is on and ready.
2. Login to the Administration mode, using the Health Physicist role (see Gaining Access to the Administration Mode (page 5-3)), then select **Calibration**, followed by **Cal Check**. See Cal Check (page 5-39) for more information.

If the gamma option is fitted, the user must select the radiation type, either α/β or γ detectors.

To check the calibration, select the *Cal Check* button. This does not allow the calibration factor to be changed, but makes a comparison between the old and new factor.

To recalibrate the instrument, i.e., to adjust the calibration factor for a particular nuclide, select the *Calibrate* button.

Gas Flow Detectors

An option is available to use either a 'single source' or a jig, where the jig includes two sources. In both cases the user may undertake either a single radiation type calibration (alpha or beta) or calibrate different channels (both alpha and beta) at the same time on different detectors. Therefore, in the case of a jig calibration, two alpha channels and two beta channels can be calibrated simultaneously.

After an intial background check, the software prompts the user to place the source(s) over the center of each detection zone. The system will count for a period that is evaluated based upon the uncertainties requested by the user. At the end of the counting period, the detector mimic shows the calibrated detectors in green. When all the detectors are green, press the 'Done' button. The system will undertake another background check to confirm the background count rates are the same as at the beginning of the calibration process, and then press each detector to confirm the detector efficiencies are within the required range. This process should be repeated for a number of nuclides that would be found in typical contamination. At a minimum, a calibration to an alpha emitter (^{241}Am) and a beta emitter (^{36}Cl) should be undertaken.

NOTE: At the end of the calibration, the user is prompted to PASS or FAIL the calibration. If the result is not within 15% of the reference values in Table below - it may be appropriate to FAIL (or Cancel) the calibration.

Source	Detector	Energy	Type	4π Efficiency
				Rugged Grille
^{36}Cl	Hand & Body	709 keV	Beta	19 %
^{36}Cl	Foot	709 keV	Beta	20 %
^{137}Cs	Hand & Body	514 keV	Beta	19 %
^{137}Cs	Foot	514 keV	Beta	23 %
^{241}Am	Hand & Body	5.5 MeV	Alpha	14 %
^{241}Am	Foot	5.5 MeV	Alpha	13%

Gamma Sintillation Detectors

Because most of the gamma detectors are hidden hehind the gas flow detectors, it is necessary to identify the center of each detector. Two red arrows point to the center of each detector; the center of the detector is at the intersection of the direction of the two arrows.

Duing the calibration process, point sources are placed at a reproducible distance from the center of the scintillation detector. In practice, this will also be a fixed distance from the gas flow detector grille, placed about the scintillation detector by the gas flow grille).

The system will display a list of pre-defined point sources. For the gamma scintillation detectors, a calibration to both ^{137}Cs and ^{60}Co should be undertaken.

NOTE: Ensure that each source is at least 20 feet away from the PM12 during the background measurement.

At the end of the calibration, the user is prompted to PASS or FAIL the calibration. If the result is not within 15% of the reference values in the table below, it may be appropriate to FAIL (or Cancel) the calibration.

	^{60}Co (1.2 MeV)	^{137}Cs (662 keV)	^{57}Co (125 keV)	Co-Win – ^{60}Co
Centroid	24 %	11.5 %		8.5 %
Foot (contact)	15.8	8.4 %		6.7%
Head	31 %	14.5 %		17 %
Side of Head	31 %	13.5 %		17 %
Hand	7.7 %	3.4 %		2.7 %
Body Top & Middle	19 %	9.0 %		7.5 %
Body Bottom	12.5%	6.5 %		5.0 %

NOTE: If the efficiency is very different from the expected value and the background is stable, perform an HV scan (see Performing the HV Scan (page 9-4)) and repeat this procedure.

The Instrument Configuration Report (see Reports (page 5-63)) will provide a hard copy of the set-up and calibration results.

Calibration for Other Nuclides

Calibration mixes

The iPCM12 will allow "calibration streams" to be set, which will include a number nuclides and their associated percentage in the mix. The iPCM12 will take account of the respective efficiency of the nuclide and the percentage, to evaluate the overall efficiency of the iPCM12 to the mix. Note that even when the iPCM12 is calibrated to a single nuclide, such as ^{36}Cl, this is still treated as a single nuclide stream. Only those nuclides to which the iPCM12 has been calibrated may be included in the mix.

Calibration (page 5-16) and Cal Streams (page 5-45) illustrate how to create the mix for a new calibration stream.

It is not essential that the percentage of all the nuclides entered adds up to 100%. In this situation, the iPCM12 will assume the unidentified percentage is due to undetectable nuclides, such as ^{55}Fe, and adjust the overall percentage efficiency to the mix appropriately.

Chapter 11 Maintenance and Trouble Shooting

Fault Messages

The fault messages produced while in the application are directly controlled by the software written by Thermo Fisher Scientific, whereas errors reported from the motherboard BIOS or the Window's operating system will be supplier dependent.

Power-up Screens

When switching the system ON, the screen will remain blank for several seconds while the BIOS carries out basic checks on the motherboard. A momentary "white flash" on the LCD is a positive indication of a good initial boot. The screen will eventually show scripting that details the progress of these initial tests. Should a fault be found, the process will halt with the fault/error detailed. This should be recorded and reported to the Thermo Fisher Scientific Service department. The equipment cannot be used until the fault is rectified.

NOTE: A failure of the LCD backlight module will leave the display blank even though "boot-up" is taking place correctly.

In a normal boot-up, the BIOS' sequence of tests will be followed by loading the operating system from the disk drive, signalled by the Thermo Fisher Scientific log screen. Any failure here will result in a "blue" screen. Again, you will need to contact Thermo Fisher Scientific's service department if this occurs.

Finally the application software will load and the iPCM12 User screen will display.

Self Test Screens

The application is entered with tests to verify the detection components are working correctly. Should a failure occur during these initial checks then the "Out of Service" message will appear on the message bar and one of the following will display on the message bar:

- Unable to set detector alarms
- Database Offline
- Unable to Configure Detector Subsystem

- Invalid Language Setting
- Default Calibration has no Alarms
- Configured Error
- Failed to Retrieve Sound Data From Database
- No Default Calibration Selected
- X-Channel Failure
- X-Channel Failure Accessing Node {0}, ID {1}

Device Error Messages

If one of these messages occurs, a fault with a peripheral device is indicated. Normal operation of the iPCM12 can be continued when action has been taken to rectify or circumvent the problem.

PRINTER NOT ACCEPTING DATA - The printer refused to accept data for over ten seconds. This may be due to the printer being disconnected, off-line, or turned off. Check the printer and the connection to the iPCM12 (see Network Communications (page 3-17)).

Operational Self Tests

While the iPCM12 is in Background Checking mode, certain aspects of the instrument's operation are tested repeatedly. If a fault is detected, the iPCM12 will display the appropriate message as follows:

- Amplifier Failure
- Amplifier Counter Failure
- Amplifier Counter Overflow
- Amplifier HV Over Current
- Amplifier HV Over Voltage
- Amplifier HV Under Current
- Amplifier HV Under Voltage
- Amplifier Dead Time Saturation
- Amplifier EEPROM failure
- Lamp Control Failure
- X-Channel Failure
- X-Channel Failure Node {0}

The fault messages produced while in the application will, typically, result in the "OUT of SERVICE" and "Critical Error" messages displaying. Reference to Out of Service (page 5-112) may assist to clear this fault and allow continued operation.

An extreme failure may result in the Window's "blue" screen halting further activity. This will require rebooting the software. However, continued occurrence of this fault would suggest a serious problem that needs reporting to the Thermo Fisher Scientific service department.

Servicing of the Electronic Assemblies

The Electronics and Display Chassis (Drawing D92520/A**)** is mounted on the upper left side of the Electronics Housing, accessed via the locked service door. It comprises the ETX processor module and Motherboard 5712A, HV generator 5713A, DC/DC converter 5714C, USB Hub, Gas Control Chassis, and LCD/Touchscreen sub-assembly.

CAUTION: AS A MATTER OF GENERAL ELECTRICAL SAFETY AND FOR CONTINUED EMC PERFORMANCE, ANY EARTH TAGS, WIRES, CONNECTORS OR COVERS REMOVED FROM ANY PART OF THE IPCM12 IN THE COURSE OF SERVICING MUST BE REFITTED AND FIXINGS SECURELY TIGHTENED. CARE SHOULD BE TAKEN AT ALL TIMES NOT TO SHORT THE BATTERY TERMINALS.

Access to Electronics Housing

WARNING: THERE ARE POTENTIALLY DANGEROUS (HAZARDOUS LIVE) VOLTAGES IN THE ELECTRONICS HOUSING, WITHIN THE HV GENERATOR MODULE, MAINS PSU MODULE AND ADJACENT MAINS SWITCH HOUSING. THESE ARE FITTED WITH SAFETY SCREENING COVERS.

***SERVICING AND REPAIR OF THIS EQUIPMENT SHOULD ONLY BE UNDERTAKEN BY SUITABLY QUALIFIED AND COMPETENT* PERSONNEL AWARE OF THE HAZARDS AND RELEVANT PRECAUTIONS.**

PRIOR TO SERVICING AND REMOVAL OF SAFETY SCREENS, SHUT THE IPCM12 DOWN, USING THE KEYSWITCH IF NECESSARY; TURN THE INTERNAL MAINS SWITCH 'OFF' AND ISOLATE THE EXTERNAL MAINS SUPPLY.

!! CAUTION: THE BATTERY IS STILL CONNECTED !!

WHEN SERVICING THE BATTERY CONTROLLER AND HV GENERATORS, DISCONNECT THE BATTERY

SUPPLY CONNECTOR FROM THE BATTERY CONTROLLER BOARD.

Access to the Electronics Housing is via the right hand locked door panel.

When servicing, refer to Interconnection Diagram D92952 Sheet 1.

Removal of the Electronics Chassis –Top Left Cabinet Corner

NOTE: Before beginning this operation, disconnect the two battery cables (B92059/A and 5659B) from the 5703A/5720A Battery Controller board located at the bottom left side of the Power Chassis.

Alternatively, see Battery - Removal and Replacement (page 11-7) for guidance.

In exceptional circumstances, when carrying out major servicing work on the Electronic display chassis D92520/A, it is best to remove it from the iPCM12. Remove the chassis from the main frame as follows; because the assembly is complete, stand-alone testing is also possible.

Detach the service door stay to allow access to the gas chassis at the top left hand corner. Before removing the main chassis, first remove the gas chassis D92610/A, by unscrewing 4 x M4 hex retaining studs. Disconnect the gas lines from the chassis (MAKE A NOTE of the gas links for later reconnection) if necessary, refer to D92591 sheet 4 (see Drawings list (by assembly) (page 13-1)).

Disconnect the following *external* cables from the boards on the chassis:

1. PSU cables B92594/A and B92597/A
2. USB cable on SK4
3. Gas chassis cable 703025KF
4. X-channel: external yellow cables at SK4,6,7,13 and 14 (leaving only SK8 connected)
5. Lamp indicator cables B92596/A and B92781/A
6. Loud speaker cable 11705242
7. Network cable in SK201
8. 2 x HV (red) cables on 5713A generator module

The Electronics Chassis can now be freed by removing the 10 x M6 hex retaining studs (M10 spanner/socket required) securing the chassis to the panel.

Hold the assembly and lift out so that it is clear of the top left corner frame.

When refitting the Electronics display chassis into the top left corner frame, ensure:

- All the cards are securely screwed down.
- ETX assembly and heat sink are correctly fixed.
- Disk drive cable is correctly fitted.
- All ten M6 fixing bolts are fitted and tightened.
- All cables are returned to their associated plugs/sockets; connect battery cables last – refer to D92591 sheet 1 as necessary.
- All earthing points are restored and securely tightened.

- Restore the cable harnesses to their original wrapped condition.

Removal and Replacement of the Power Supply

IMPORTANT: Before any work starts ensure that the AC Mains supply is disconnected from the iPCM12 and the iPCM12 is powered off at the front panel keyswitch.

1. Unlock the right hand side service access door. The AC mains power supply (PSU) is mounted on the Power Chassis in the lower left section of the main frame.
2. Disconnect the external AC mains supply at the IEC connector on the iPCM12 top plinth; locate the PSU assembly and switch the rocker switch to OFF. Remove the two screws retaining the rocker switch cover protective lid.
3. Remove the connections of cable B92261/A (supply input) and B92603/A (output) and the earth strap to the earth point.
4. Unscrew and remove four mounting plate corner screws to extract the PSU assembly. The AC Mains PSU, including its internal fuse, is not user serviceable.

AC Mains Power Supply Replacement

The Power Supply module contains dangerous (Hazardous Live) high switching voltages and is not user serviceable. It should be returned to the Thermo Fisher Scientific service department for repair or replacement.

Be sure to use the correct type of replacement power supply (See Recommended Spares List (page 12-1)). Replacement of the Power Supply is the reverse of the removal procedure. Replace the connections ensuring all the clamping screws are tight and all GROUND/EARTH connections are securely made. Ensure the ON/OFF rocker switch cover is replaced to protect the user from AC Mains voltage hazards.

Adjustment of PSU

There is no PSU adjustment.

AC Mains IEC Socket / Filter/IEC Replacement

The combined AC Mains IEC socket and Filter assembly is located in the side section of the roof plinth. Switch the iPCM12 OFF at the PSU assembly, isolate the external AC Mains supply, and disconnect the IEC power cord. Remove the two screws securing the safety cover.

In the event of failure, the IEC Filter must be replaced with one of identical type (See Recommended Spares List (page 12-1)) to preserve EMC performance and safety integrity. When re-

connecting the mains wiring, **ensure the mains inlet earth connection is made securely to the Central Earth Point (CEP).** Ensure the metal safety cover is re-fitted and tightly secured. These requirements are mandatory and necessary for continued EMC performance and user safety.

Battery - Removal and Replacement

IMPORTANT: Care should be taken at all times not to short the battery terminals.

The battery is a sealed lead/acid Gel-Cell type construction and does not require regular maintenance. The battery should be periodically tested for capacity. Charging is carefully temperature and voltage/current controlled, so the battery generally has a long life – typically in excess of five years. If it requires replacement, proceed as follows:

1. Switch OFF the following: iPCM12 (keyswitch). and PSU (Rocker switch)
2. Disconnect the following: external mains supply (top plinth) and the battery cables from the Battery Controller Board - 5703A PL5 and PL7) or 5720A (PL7 and PL9).
3. Remove the angle bracket (two screws) covering the battery holder; remove the battery compartment top cover (four screws). Lift out metal brackets.
4. Tilt the battery out to reveal the connecting cables.
5. Disconnect the thermistor assembly from the negative BLACK terminal marked '-', taking care not to short it to the '+' terminal.
6. Disconnect the red wire from the positive RED '+' terminal taking care not to short it to the '-'terminal.
7. Remove the battery and dispose of it safely as required. The battery should be replaced only with one of a similar type, or operation of the iPCM12 may be impaired.
   When refitting the battery, make sure the mounting bracket is properly secured.
8. Reconnect the red wire to the RED '+'terminal first.
9. Reconnect the thermistor card to the BLACK '-'terminal last. Failure to do this may impair charging control and may lead to premature battery failure.

CAUTION: THE BATTERY CONTAINS HAZARDOUS SUBSTANCES; PLEASE TAKE CARE TO DISPOSE OF THE OLD BATTERY IN ACCORDANCE WITH YOUR LOCAL REGULATIONS – IN EUROPE DIRECTIVE 2006/66/EC.

Hard Disk Drive Removal and Replacement

The Hard Disk is an integral part of the 5712A Processor Motherboard, situated near the top of the Electronics Chassis.

Shut down the iPCM12. Remove the two screws securing the retaining bracket at the top of the disk casing. Unplug the disk drive from the lower PCB connector.

Replacement of the Hard Disk

The Hard Disk should be replaced with an identical unit (See Recommended Spares List (page 12-1)) of 40 Gbyte minimum capacity, preloaded with all necessary software. Replacement of the disk is the reverse of the removal procedure.

When the instrument is first started with the replacement disk, the application will signal "out of service" because of missing calibration data.

This data, which is held in flash memory (also found on the 5712A Processor Motherboard), needs to be transferred to the new disk by invoking the following procedure:

1. Access the Administration Mode (see Gaining Access to the Administration Mode (page 5-3)). Select System and Exit to Administrator Logon.
2. Insert a USB keyboard and LOG ON to Windows as an Administrator (see Gaining Access to the Administration Mode (page 5-3)).
3. RUN "Restore.bat" in C:\IPCM Database\scripts.
4. Log off Windows.
5. Log on to Windows as Thermo User.

Battery Controller Board Type 5703A and 5720A - Removal and Replacement

1. Shut down the iPCM12 using the keyswitch.
2. Switch the AC Mains PSU rocker switch OFF.
3. The Battery Controller PCB is situated at the bottom of the Electronics Chassis. First, disconnect orange/black Battery Supply from the PCB – 7503A PL7 or 5720A PL9.

Figure 19 Battery Controller PCB

4. Disconnect all other cables and remove the four M3 hex pillars and washers securing the PCB to its mounting spacers. The Battery Controller PCB is now free to be removed from the Electronics chassis.

Replacement of the Battery Controller PCB

The Battery Controller PCB should be replaced with one of an identical type (see Recommended Spares List (page 12-1)). Replacement of the charger PCB is the reverse of the removal procedure (5703A PL7 or 5720A PL9 last).

Take care to locate all connectors correctly (ensure connections are not “offset”), particularly the keyswitch connection to 5703A PL6.

ETX Processor Motherboard Type 5712A - Removal and Replacement

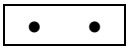
1. Shut down the iPCM12 using the keyswitch.
2. Switch the AC Mains PSU rocker switch OFF.
3. Disconnect all of the cables from the 5712 Motherboard – note connector positions for reference.
4. Remove the six hex pillars retaining the PCB to its mounting spacers. The PCB can now be lifted away from the Electronics display chassis.

Replacement of the ETX Motherboard

Replacement of the 5712A ETX Processor Motherboard is the reverse of the removal procedure. If the main ETX processor module is thought to be faulty, it should be replaced with an identical unit (see Recommended Spares List (page 12-1)) as detailed below.

1. Transfer the Compact Flash memory card from the old 5712 PCB to the new one; this card contains all the necessary configuration data.
2. If using a new Hard Disk on a replacement 5712A Motherboard, ensure that all the correct software is pre-loaded.
3. Set the Links on the 5712A as follows:

LK1



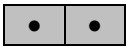
LK3

LK2

LK5

LK4

LK9



Replacement of the ETX Processor Module

1. Shut down the iPCM12 using the keyswitch.
2. Switch the AC Mains PSU rocker switch OFF.
3. Remove the 5712A Processor Motherboard as detailed above.
4. Remove the four screws securing the four corners of the ETX processor module to the 5712A PCB.
5. Carefully lift the ETX module clear of the PCB. It is located on four 100-way high density connectors that create significant contact friction, so considerable force may be required to release the ETX module.
6. The replacement ETX Module should be of the same type as the original, (see Recommended Spares List (page 12-1)) and pre-assembled with a heatsink assembly. In the event that a heatsink assembly is not fitted, it will be necessary to transfer the one from the original ETX module.
7. Release the screw in the center of the heatsink and pull it off the processor PCB – note its orientation with respect to the thermal pads and major ICs. Inspect condition of the thermal pads – if damaged; apply a small amount of heatsink compound to the damaged area to ensure good thermal conduction.
8. Transfer the heatsink to the ETX board, ensuring correct orientation, and refit the center screw.
9. Place the 5712A Motherboard on a flat and even surface and align the ETX module's four 100-way connectors.
10. Place the palm of the hand on top of the heatsink and push down evenly and firmly until the module "clicks" into place on all four connectors.
11. Secure the ETX module to the 5712 PCB with the four corner fixings.
12. Refit the 5712A ETX Processor Motherboard into the Electronics chassis as detailed above.

DC-DC Converter Type 5714C - Removal and Replacement

1. Shut down the iPCM12 using the keyswitch.
2. Switch the AC Mains PSU rocker switch OFF.
3. The DC-DC Converter board, type 5714C is located immediately below the 5712A Processor Motherboard. Release the four power cables (B92597/A, B92603/A, B91918/A, and B92604/A) from the 5714C PCB, noting their positions.
4. Remove the six hex pillars securing the PCB to the Electronics Chassis.

Figure 20 DC-DC Converter PCB

Replacement of the DC-DC Converter Board

Replacement of the 5714C is the reverse of the removal procedure. If the converter is thought to be faulty, it should be replaced with an identical unit (see Recommended Spares List (page 12-1)).

Gas Flow HV Generator Type 5713A - Removal and Replacement

WARNINGS: THE HV 5713A BOARD GENERATES DANGEROUS (HAZARDOUS LIVE) HIGH DC VOLTAGES. EXERCISE CAUTION WHEN SERVICING. ALWAYS DISCHARGE THE HV BEFORE BEGINNING WORK.

BE AWARE THAT AFTER INITIAL DISCHARGE, DIELECTRIC ABSORPTION IN THE CAPACITORS CAN CAUSE SUBSEQUENT HV REGENERATION!!!

The Gas Flow HV Generator, type 5713A, is located on the lower right side of the Electronics Chassis.

1. Shut down the iPCM12 using the keyswitch.
2. Switch the AC Mains PSU rocker switch OFF.
3. Allow two minutes for the HV to discharge before removing the two network cables. Carefully disconnect the two red HV output cables and short the connector pins out on adjacent (earthed) metalwork to discharge the detector system.
4. Ensure the red HV Enabled LED is extinguished and the HV is discharged before proceeding to remove the safety cover and handling the board.
5. Remove the six retaining screws to remove the safety cover. Remove the six hex pillars to release the HV board.
   The 5713A HV Generator is not user serviceable.
6. Replace a faulty 5713A board with an identical unit (see Recommended Spares List (page 12-1)).
7. When fitting a new board ensure the links are set as follows:

LK1	OPEN	LK2	Open (Solder bridge)
LK3	Open (Solder bridge)	LK4	Open (Solder bridge)
LK5	Open (Solder bridge)	LK6	Fitted (HV Enable)
LK9	Fitted		

Replacement of the 5713A is the reverse of the removal procedure. Ensure the safety screen is refitted and screws are securely tightened.

Scintillation HV/Amplifier Type FHT681 - Removal and Replacement

WARNING: THE HV and AMPLIFIER PCBS GENERATE DANGEROUS (HAZARDOUS LIVE) HIGH DC VOLTAGES. EXERCISE CAUTION WHEN SERVICING; ALWAYS ALLOW THE HV TO DISCHARGE BEFORE BEGIN WORK.

Up to five Scintillation HV/Amplifier modules, Type FHT681 may optionally be fitted into the upper cabinet bulkhead on the right side of the Electronics Housing. The PCB is located within the cabinet bulkhead and only the four front panel connectors are visible.

WARNING: BEFORE ATTEMPTING TO REMOVE ANY FHT681 MODULE, SWITCH THE iPCM12 OFF AND WAIT 1 MINUTE FOR THE HV TO DISCHARGE BEFORE BEGINNING WORK.

1. Disconnect the front panel MHV co-axial connectors – note cable connections for re-assembly.
2. Remove four front panel screws to release the FHT681 module and carefully withdraw the PCB from the bulkhead.
3. Disconnect the rear two daisy-chained (X-Channel I) gray network ribbon cables that link the assembly to the ETX processor.

NOTE: All the FHT681s are connected via PL12 on 5712A.

Replacement of the FHT681HV-Amps

Replacement of any of the boards is the reverse of the removal procedure. If any board is thought to be faulty it should be returned to Thermo Fisher Scientific's service department for repair, and replaced by another FHT681 module of the same type (see Recommended Spares List (page 12-1)).

When replacing any amplifier, note and record the new FHT serial number – this unique "node" identification must be entered into the X-Channel software configuration.

Ensure the detector cables are re-connected to the correct amplifier and connector.

NOTE: All FHTs MUST be linked using the rear (gray) ribbon cables**.**

Changing the FHT681 Address

Replacement of any FHT module will subsequently produce an "X-Channel error" message. Logout, insert the administrator **Dongle**, and logon as Administrator (see Gaining Access to the Administration Mode (page 5-3)).

Using the touchscreen:

1. Select the *Set-UP* Menu.
2. Select *X-Channel* tab.
3. Select *Gamma* Detection System radio button.
4. The scintillation detectors associated with the newly fitted FHT681 will register as *No Connection* and show red on the display.
5. Touch the red detector graphic to select it.

6. Touch the *Address* box, and enter the new FHT "node" address (FHT serial number).
7. Touch the *Apply Settings* button.
8. The detector should now be Connected, and the graphic show green.
9. Repeat until all detectors are connected.
10. Exit this routine and log on as Thermo User again.

Setting the FHT681 Current Limits

When an FHT681 is exchanged, it will be necessary to check that the Min and Max current levels for each detector are set at "50" and "200", respectively, using the HV Scan (page 5-46) facility. If they are still set to "0" and "255", they will need resetting with the same facility.

NOTE: When these values are correctly set the application will be able to report any detector disconnection or light leak.

LCD Display, Touch Screen, Touch Controller, and Backlight Inverter - Removal and Replacement

WARNING: THE BACKLIGHT INVERTER GENERATES DANGEROUS (HAZARDOUS LIVE) HIGH VOLTAGES. EXERCISE CAUTION WHEN SERVICING; ALWAYS ALLOW THE HV TO DISCHARGE BEFORE COMMENCING WORK. DO NOT REMOVE THE INVERTER FROM ITS PROTECTIVE SCREENING ENCLOSURE.

Refer to assembly drawing D92563/A for details.

1. Shut down the iPCM12 and ensure the AC Mains Switch is OFF.
2. Remove the whole Electronics and Display assembly to gain access to the LCD display subsystem.
3. Remove the six hex pillar screws from the rear of the display housing and remove the ETX processor board 5712A – as detailed above. Release the back-plate.
4. The back-light and Touch-screen controller cards lie beneath removable protection covers on the back of the display.
5. Take care in removing the connecting cables.
   Both the Touch Controller module and the Back-light Inverter are proprietary items and are not user serviceable. They should be returned to the Thermo Fisher Scientific service department for repair or replacement.

6. To remove the LCD display, disconnect all three cables.
7. Undo the display retaining screws located round the periphery of the metalwork.
8. Gently pull the front bezel assembly away from the main housing and lay carefully onto a flat surface.
9. Remove the four screws attaching the LCD shield to the front bezel.
10. Lift the LCD and shield from the bezel and touch screen, (sitting in a recess of the plastic bezel). The touch screen is not fixed to the bezel.
11. Remove the four screws holding the aluminum shield to the LCD via spacers.

Replacement of the LCD Display, Touch Screen, Touch Controller, and Backlight Inverter

Replacement of the LCD Display, Touch Screen, Touch Controller and Back-light Inverter is the reverse of the removal procedure. Should any item be thought faulty, replace with an identical part (See Recommended Spares List (page 12-1)).

NOTE: Take special care in handling the Touch Screen and LCD to keep all faces free of dirt and finger marks!

If the Touch Screen is replaced, it will be necessary to re-calibrate it using the software utility provided.

User Guidance Display Guidance 5711A and LED Cluster Board 5672A - Removal and Replacement

WARNING: BEFORE SERVICING EITHER OF THESE ASSEMBLIES, ENSURE THE IPCM12 IS SHUT DOWN AND THE POWER IS OFF - FAILURE TO DO THIS WILL RESULT IN DAMAGE TO THE I^2C BUS SYSTEM COMPONENTS!

The User Guidance Display, type 5711A, is located at the left inner side of the body detector array assembly, at head height.

1. Prize off the outer label the face of the display and gain access to the six countersunk fixing screws.
2. Remove the fixing screws. Ease the display forward and disconnect the six-way colored ribbon cable B92596/A.
   DO NOT allow the cable to fall back inside the housing; firmly tape the cable for future reconnection.
3. Apply a new overlay label (B92433) to the 5711A display face.
4. Locate the one, or optionally two, 5672A LED “traffic light” clusters in the front face/s of the cabinet. Exact

location is dependent upon either User preference or Closed unit options selected.

5. Remove the 6 x M3 hex pillars on the rear paneling and disconnect the 6-way colored ribbon cable. Note each board (PL1 or PL2) connection. There is no need to remove the front labeling.

The LEDs are proprietor items and therefore are not user serviceable. The boards should be replaced with identical parts as detailed in Recommended Spares List (page 12-1).

Body Sensor Assemblies - Removal and Replacement

The Body Sensor assemblies are connected to I/O ports on Gas Flow Detector 5704A Quad Amp boards via PL4 (TX) and PL3 (RX). Data communication is via the X-Channel internal network to the 5712A ETX Processor Motherboard.

All seven body sensors are infra-red photobeam pairs, each pair having a separate transmitter light source (TX) and receiver (RX) – both are in physically identical packages. Each Body Sensor connection is via a pre-determined detector Quad Amp, dedicated and fixed in software – body sensor locations are not user configurable. The sensor locations and cabling are as shown on interconnection diagram D92591 sheet 6; the sensor housings are listed on the iPCM12A family tree D92525.

Replacement of the Sensor Assemblies

Individual sensor assemblies are located in either aluminum or plastic housings. Remove by unscrewing two M3 countersunk screws, unwiring the sensor leads, and unplugging the ribbon cable(s).

The sensors are proprietor items and therefore are not user serviceable. They should be replaced with identical parts as listed on the family tree D92525. Active RX/TX sensors are detailed in Recommended Spares List (page 12-1).

After renewal, connect the individual sensor wiring as indicated on D92591 sheet 6 and remount using two M3 countersunk screws.

Gas Flow Quad Detectors - Removal and Replacement

All iPCM12 variants are populated with 21, or optionally 23, Gas Flow Quad Detectors, type 5710A.

The detector body is machined from a solid aluminum extrusion. It has a thin, aluminized Mylar, light-tight “window” foil on the front, sensitive surface. A charge-sensitive quad channel amplifier is mounted directly onto the back of the detector body. This single size of detector is used to monitor all areas of the body, so a single purged, spare

detector (located inside the service door) will service all detector locations.

WARNING: THE FRONT, WINDOW FOIL IS NECESSARILY THIN AND THEREFORE EASILY DAMAGED AND PUNCTURED. HANDLE WITH CARE AT ALL TIMES – USE A PROTECTIVE WINDOW COVER (e.g., CARDBOARD) WHEN TRANSPORTING DETECTORS. WHEN FITTING REPLACEMENT DETECTORS, TAKE CARE THAT CABLES, CONNECTORS, EMC STRAPS AND OTHER SHARP OBJECTS DO NOT PUNCTURE THE WINDOW FOIL.

CAPACITIVE DIELECTRIC ABSORPTION EFFECTS CAN CAUSE HV REGENERATION SUBSEQUENT TO INITIAL DISCHARGE. WHEN REMOVING DETECTORS, FIT AN "HV SHORTING LINK" (LOCATED ON THE SPARE DETECTOR INSIDE THE SERVICE DOOR), TO DISCHARGE THE HV CONNECTOR VIA THE DETECTOR BODY – SECURED BY THE KNURLED KNOB.

1. Before servicing detectors, shut down the iPCM12 and switch OFF the power. Allow several minutes for the HV to discharge before handling.
2. Prepare a "purged" spare detector: Ensure the replacement detector is thoroughly "purged" of air and contains a good charge of gas (window foil gently "plumped" by internal back-pressure).
3. Using a length of (purged) gas tubing, *quickly* disconnect the spare detector and link its two gas connectors to create a sealed detector assembly. This assembly can be transported to the repair site without air ingress.

General Gas Flow Detector Replacement Procedure

NOTE: Once access to the relevant detector is achieved, as detailed below, the following detector changing procedure is common to all locations:

1. Undo the (blue) gas connector collect at each end of the detector and slide back onto the tube – **do not disconnect the pipes yet!**
2. Obtain a suitable length of blue Festo PL3 tubing, and one or two Festo "bulkhead" connectors, as necessary. ***Quickly*** disconnect the detector gas pipes and create a gas jumper link to bypass the damaged detector (the pressure in the system will expel the air from the jumper

tube) – the bypass link will prevent air ingress into the rest of the iPCM12 system.

3. **Observing relevant precautions above**, disconnect the HT lead (red), network cables (yellow), and any sensor wiring (red/black).
4. Release the EMC earthing straps and bend them well clear.
5. Release the two Velcro retaining straps and withdraw the detector.
6. Ensure all pipes, cables, connectors, and EMC straps are clear of the immediate repair area prior to fitting the replacement detector. Ensure the protective grille is fitted inside the iPCM12 frame and located correctly.
7. *Carefully* fit the replacement detector – ***observe correct orientation of the amplifier and HV connector!***
8. Ensure the replacement detector is correctly seated in its frame and in contact with the protective grille. Buckle and secure the Velcro straps, re-fit all connectors and ***ensure the EMC strap is fitted and the knurled knob securely tightened.***
9. ***Quickly*** re-fit the gas tubing to the gas connection at each end of the detector – fit the collets afterwards and ensure they are securely (finger) tight.

Access to specific Gas Flow Detectors is as follows:

Body and Top-of-Foot Detectors

1. Unlock the body detector array frame – top and center.
2. Hinge the detector arrays outward to the left hand side. This gives access to the rear of all 12 body detectors.
3. Clear access to the Top-of-Foot detector.

Side-of-Leg, Inner Hand and Side-of-Foot Detectors

1. Unlock the body detector array frame – top and center.
2. Hinge the detector arrays outward to the left hand side.
3. Unlock the Island Assembly and hinge it outward, toward the body array frame. This gives access to the two Side-of-Leg detectors, the Inner Hand (Palm) detector and the Side-of-Foot detector. Each side-of-foot detector is located against the protective grille by two swivel clamps, each released by a knurled knob. Remove the detector vertically.
   Note that the protective grille used with the side-of-foot detector (one of three grilles) is smaller than all other body grilles.

Shoulder, Side-of-Head and Outer Hand Detectors

These detectors are all accessible via the right hand service door. Note that the Shoulder and Side-of-Head detector protective grilles are (two of three grilles) smaller than all other body grilles.

A bracket, with integral hand mechanism "bumpstops" retains the Outer Hand (Back of Hand) detector, and is retained by two knurled knobs. Remove this bracket before releasing the detector body from its lower spring clip and withdrawing it vertically from the hand mechanism.

Overhead Detector (1)

This is located inside the roof section, facing downwards, and retained by two Velcro straps. It is necessary to first remove the roof cover to gain access to the overhead detector. Ensure the earth and EMC straps are refitted to the underside of the roof cover.

Foot Detectors (2)

1. Open the body detector array frame to gain clear access to the foot plinth. (It may be necessary to remove the two black hex-countersunk transit screws securing the tread plate – these need not be replaced, but safely stored for future use).
2. To remove the foot plinth tread plate assembly, use the two "foot well lifters", located in a slot inside of the service door. Insert the two lifters into the two photobeam apertures in the black plastic tread plate, nearest you.
3. Lift the tread plate up a short distance and, tilting the Top-of-Foot detector backwards, lift the tread plate over the central foot sensor housing and clear of the foot plinth. The foot detectors are now exposed.
4. Prior to lifting out the foot detectors, remove any debris that may have collected - a small/portable vacuum is ideal.
5. Lift out the foot detector and place it upside down on the adjacent foot detector – to protect the window foil.

Note foot photobeam sensor cable connections prior to disconnecting. Foot detectors are serviced as described in the general procedure above.

Refitting and connection of the foot detectors is the reverse of the removal procedure. Ensure that:

- Photobeam sensor connections are correct.
- All excess cable is securely tucked into the cable tidy.
- **No cables are trapped under the detector mountings.**

- **Gas pipes are not trapped under the detector or "kinked"**
- **The detector sits flat on its mounting tabs – it should not rock!**

Replacing Gas Flow Detectors Windows

1. In a dust-free environment, lay the defective detector on a flat work surface so that the window is uppermost
2. Remove the 14 countersunk screws retaining the window support plate.
3. Remove the damaged window foil and discard. Take care not to damage the internal anode wires and not to allow dust or moisture ingress.
4. Carefully place a new pre-foiled window carrier (B92412/A) over the O-ring.
5. Taking care not to damage or puncture the new window, replace the screws in the window support plate.
6. Connect the repaired detector to the spare gas circuit inside the iPCM12 service door or otherwise to a test/purge gas installation to purge out the air for immediate re-use.

Configuring a Replacement Detector

1. Log-in.
2. Select the Setup menu and X-Channel tab.
3. Select the detector graphic and enter the new detector X-Channel *node* address (this is the serial number of the Amplifier fitted to the detector).

Scintillation Detector Removal and Replacement

Optional Scintillation Gamma detectors can be fitted to all variants of the iPCM12. However, the Full Body gamma option (AE0222) and other options requiring the rear lead shadow shielded wall can only be fitted to the *Closed* iPCM12B and iPCM12C variants.

NOTE: Scintillation detectors are light sensitive and are wrapped in a light-tight jacket. Care must be exercised at all times not to damage the light-tight jacket, as subsequent damage to the photomultiplier tube will result.

If it is necessary to remove lead shielding, observe the following precautions

Removal

WARNING:

ALL LEAD SUPPLIED IS "BLUED" (LACQUERED) FOR HANDLING PURPOSES. HOWEVER, OBSERVE LOCAL HEALTH &and SAFETY HANDLING REGULATIONS AT ALL TIMES. GLOVES ELIMINATE THE POSSIBILITY OF SURFACE CONTAMINATION – BUT MUST BE OF A SUITABLE "HIGH GRIP" VARIETY TO AVOID LEAD SLIPPING – OBSERVE LOCAL REGULATIONS.

ALWAYS WASH HANDS AFTER HANDLING LEAD.

LEAD SHIELDING IS HEAVY, BUT EACH SECTION IS DESIGNED TO MEET THE UK HEALTH & SAFETY LEGISLATION. THE WEIGHT OF EACH SECTION IS IN ACCORDANCE WITH THE LIFTING LIMITS RELATING TO ITS PHYSICAL POSITION. NO SECTIONS EXCEED 35 KGS. ALWAYS FOLLOW THE CORRECT HANDLING PROCEDURES TO AVOID PERSONAL INJURY.

ENGAGE ASSISTANCE.

Body Gamma Detectors (6)

Disconnect the mains supply. Ensure the iPCM12 is switched OFF.

1. Unlock and hinge the body array frame open to reveal the body scintillation body detectors.
2. Before lifting out the detector, disconnect MHV coaxial cable.
3. Carefully unbuckle the Velcro straps.

CAUTION: EACH 5717A DETECTOR WEIGHS ABOUT 10KG.

TAKE CARE THAT THE DETECTORS DO NOT FALL!!

Overhead Detector (1)

1. Remove the roof cover to reveal the head detector.
2. Remove the two lead shielding sections from the detector.
3. Disconnect the MHV coaxial cable.
4. Carefully withdraw the 5708A detector.

Foot Detector (1)

1. Open the body detector array frame to gain clear access to the foot plinth. (It may be necessary to remove the two black hex-countersunk transit screws securing the tread plate – these need not be replaced, but safely stored for future use).
2. To remove the foot plinth tread plate assembly, use the two “foot well lifters” located in a slot inside of the service door. Insert the two lifters into the two photobeam apertures in the black plastic tread plate nearest you.
3. Lift the tread plate up a short distance and, tilting the Top-of-Foot detector backward, lift the tread plate over the central foot sensor housing and clear of the foot plinth. The gas flow foot detectors are now exposed.
4. Prior to lifting out the gas flow foot detectors, remove any debris that may have collected - a small/portable vacuum is ideal.
5. Lift out the right gas flow foot detector and place it upside down on the adjacent foot detector to protect the window foil.
6. The scintillation foot detector is now exposed.

- Disconnect the MHV coaxial cable.
- Carefully lift out the 5708A detector.

Hand Detector (1)

1. Open the right hand iPCM12 service access panel to reveal the hand detector fitted to the inside face of the door.

CAUTION: THE SCINTILLATION HAND DETECTOR AND ITS LEAD SHIELDING IS A COMPLETE ASSEMBLY, CONTAINED WITHIN A SHEET METAL HOUSING – IT IS DECEPTIVELY HEAVY!!!

ENGAGE ASSISTANCE.

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2. Disconnect the MHV coaxial cable.
3. Remove the six M4 detector housing retaining nuts – the bottom three first, followed by the top outer pair. While removing the final top center nut, hold the housing onto its retaining studs and stand with feet well clear of the housing.
4. Carefully lift the whole assembly off its mounting studs and **hold it with the black plastic front face toward the floor** to prevent the lead shield and detector from falling from the housing.

CAUTION: TAKE CARE THAT THE DETECTOR ASSEMBLY DOES NOT FALL!!

Side-of-Head Detector

1. Open the right hand iPCM12 service access panel to reveal the scintillation Side-of-Head detector fitted in place of the gas flow detector, adjacent to the FHT681 Amplifiers.

CAUTION: THE SCINTILLATION SIDE-OF-HEAD DETECTOR AND ITS REAR LEAD SHIELD ARE MOUNTED IN AN ELEVATED LOCATION AND DECEPTIVELY HEAVY!!!

ENGAGE ASSISTANCE.

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2. Disconnect the MHV coaxial cable.
3. Hold the rear lead shielding section in place to prevent it falling, while releasing the four M3 knurled retaining knobs. Carefully lift the rear lead shield away from the assembly – take care it does not fall.
4. The remaining lead shielding is fixed to the iPCM12 cabinet and does not require removal. “Wriggle” the

scintillation detector free from its lead shielding and lift it clear – ensure it does not fall.

WARNING: TAKE CARE THAT THE DETECTOR ASSEMBLY DOES NOT FALL!!

Detector Replacement

Replacement of the Detectors follows the removal procedure in reverse. Care must be exercised not to break the light-tight seals.

Once the detectors are in place, refit all spacers, straps, and panels.

Setting up Replacement Detectors for Use

Replacement scintillation detectors and detectors with replacement PMTs will need to be set for optimum performance with the Isotopes of interest. Before determining HVs, the multi-Channel Analyzer Thresholds must be reset to their default settings or erroneous results will be obtained (see Thresholds (page 5-54)). Once this is done, select the detector operating point using the ***HV Scan*** procedure detailed in Selection of Detector Operating Parameters (page 9-3).

GPIO Board (5707A)

The optional General Purpose Input/Output (GPIO) board is fitted to ***Closed*** iPCM12 variants fitted with Door, Barrier, and Turnstile systems.

1. Shut down the iPCM12 and switch the AC mains supply OFF.
2. The GPIO board is located at the bottom left corner of the main Electronics and Display Chassis, adjacent to the 5713A HV Generator and retained by six M3 hex pillars. Disconnect the signal and control cable connectors and the (yellow) X-Channel network cables and then remove the six hex pillars.

GPIO Replacement

GPIO board replacement follows is the reverse of the removal procedure. Ensure the connectors are correctly mated.

Barrier Arm and Motor Assemblies

NOTE: The motor drive system has a protective clutch to limit the impact force and stop the motor in the event an obstacle is encountered. However, when servicing, beware its "field of travel".

1. Shut down the iPCM12 and switch the AC mains supply OFF.
2. Remove the barrier arm by releasing three retaining bolts that secure it to the motor assembly.
3. The barrier motor assembly is located within the iPCM12 closed extension frame and accessed via the rear locked panels. To remove the motor assembly, the barrier arm must first be removed, as described above. The motor flange (visible externally) can then be removed by withdrawing the central fixing screw.
4. Detach the motor assembly by removing the two nyloc nuts (rear of motor) retaining the drive to the holding plate that is secured to the panel work. Unplug the control cable to allow removal of the motor.

Barrier Replacement

Replacement of the Barrier arm and motor assembly is the reverse of the removal procedure.

Trouble Shooting (Operational)

This "Trouble Shooting" section covers a number of possible operational problems, their likely causes, and possible remedial action.

WARNING: EXERCISE EXTREME CAUTION WHEN SERVICING.

THERE ARE DANGEROUS, "HAZARDOUS LIVE", AC AND DC VOLTAGES AROUND AND WITHIN THE AC MAINS POWER SUPPLY MODULE, 5713A HV GENERATOR, FHT 681 HV/AMPLIFIER AND THE LCD BACKLIGHT INVERTER MODULE. THERE ARE ALSO HIGH DC VOLTAGES PRESENT IN THE 5710A GAS FLOW DETECTOR AND ON THE 5704A QUAD AMPLIFIER BOARDS. THE 12 VOLT BATTERY STORES CONSIDERABLE ENERGY (IT CAN DELIVER IN EXCESS OF 400AMPS) SO CARE SHOULD BE TAKEN

AT ALL TIMES NOT TO SHORT THE TERMINALS. PLEASE READ THE CAUTIONARY NOTES IN **Servicing of the Electronic Assemblies (page 11-3)****.**

SERVICING AND REPAIR OF THIS EQUIPMENT SHOULD ONLY BE UNDERTAKEN BY SUITABLY QUALIFIED AND COMPETENT PERSONNEL AWARE OF THE HAZARDS AND RELEVANT PRECAUTIONS.

Normal Start-up (Boot-up) Operation

In general a successful start, or "boot up" when the iPCM12 key-switch is turned is indicated by:

- Momentary LCD backlight “flash” and speaker “crackle”
- Series of "System Self Test" display messages
- Series of lamp tests, each accompanied by a "beep" tone
- Series of internal (invisible) self tests
- Single chime "ding-dong" on satisfactory completion

Unit "Dead" (Will Not Boot up) and Charging LED is OFF

If the display remains blank and unlit, no lamps are lit, and no sound is heard (assuming the volume has not been turned off), it would indicate that the iPCM12 is "dead".

LED OFF - indicates the AC mains supply is OFF and instrument cannot run off the battery.

1. Check the fuse on the 5703A Battery Controller PCB, F1 (6.3Amp).
2. If the fuse is intact, the battery is probably discharged. Check the voltage at PL7 on the charger PCB. If it is below 11.2 volts, the battery is discharged and the charging supply must be restored before further operation is possible.

Restoring the AC mains/charging supply - should light the LED and allow the system to run while charging the battery.

3. Check the AC mains IEC connector power cord is connected (side face of roof plinth).
4. Check the fuse in the AC mains power cord connector (if fitted).
5. Check that rocker switch is ON and power supply is receiving the mains supply.
6. Check the power supply output on 5703A PL1 (temporarily remove from PCB to check) - no output indicates the internal fuse has blown and the power

supply should be replaced (see Removal and Replacement of the Power Supply (page 11-6)).

7. Check the output on PL7 of the 5703A Battery Controller PCB - it should be greater than +12.5 volts.

Unit "Dead" (Will Not Boot up) and Charging LED is ON

Front panel LED ON - indicates that AC mains supply is ON and should be powering the instrument while charging the battery.

1. Retry switching the unit ON.
2. Check the fuse on the 5703A Battery Controller PCB, F1 (6.3 Amp).
3. Check the battery voltage is greater than 12.5 volts.
4. Check there is battery voltage on 5703A OUTPUT connector PL4. If no output is observed on PL4, a fault on the Battery Controller PCB is indicated and it should be replaced as detailed in Replacement of the Battery Controller PCB (page 11-9).
5. Check the power connections from the 5703A Battery Controller PCB to the 5714A board and 5712A.
6. Check the regulated +12 V, -12 V, and +5 V outputs from the DC-DC converter module 5714C. The DC-DC module is not user serviceable and, if faulty, the Converter board should be replaced. Switch iPCM12 unit OFF and replace the 5714C DC-DC board.
7. If the iPCM12 is still faulty, change the ETX processor board type 5712A, referring to ETX Processor Motherboard Type 5712A - Removal and Replacement (page 11-10).
8. If the iPCM12 is still dead after changing the 5714C DC-DC and 5712A processor boards, contact the Thermo Fisher Service department for assistance.

Starts-up but Display is "Blank" and Fails Self Tests (No Chimes)

If the iPCM12 starts but fails to chime ("ding-dong") within 60 seconds of being switched ON, then it has not successfully completed the power-on Self Tests and a fault is indicated. Observe the LCD display. If a fault message is displayed, refer to subsequent subsections. If, however, the display is blank or the message is unintelligible, it is likely the ETX processor board has a serious fault and the microprocessor has I/O problems or has crashed. Replace the processor board as described in ETX Processor Motherboard Type 5712A - Removal and Replacement (page 11-10).

Starts-up Passes Self Tests and Runs but Display is "Blank"

If the iPCM12 starts-up, passes Self Tests, “chimes”, and appears to run normally but the LCD display appears “blank”, it is likely the Backlight Inverter Module has failed (the LCD has *dual* CCFL backlights). The immediate and characteristic LCD backlight “flash” will be absent when the processor boots-up. The 5712A Processor must be removed to gain access to the LCD display assembly, which must be disassembled to access the Backlight Inverter Module.

WARNING: THE BACKLIGHT INVERTER MODULE GENERATES DANGEROUS “HAZARDOUS LIVE” HIGH VOLTAGES AND IS NOT USER SERVICEABLE. IT MUST BE REPLACED ONLY WITH AN IDENTICAL MODULE.

Will Not Run and Displays "Out Of Service – Low Background Counts"

The blue FAULT lamp is lit (see Fault Messages (page 11-1) for an explanation of the fault messages). The Self Tests have detected the background count from the detector channel is below the Low Background Limit value set in Monitoring (page 5-14). Proceed as follows:

1. Enter a valid password and Setup|Monitoring (page 5-14). Check that the Low Background Limit is not set to an unreasonably high value for the prevailing background condition.
2. Select Calibration|HV Scan (page 5-46) and check the HV settings for each channel are correct. It may be necessary to refer to the original manufacturing configuration print-out or to the commissioning configuration print-out for the iPCM12.
3. Check the cable connections between the 5712A processor board, the HV, and Amplifier PCBs (at PL12), and the X-Channel network cables SK1, 6, 7, 8, 13, and 14.
4. Check HV cables (red) to faulty gas flow detector(s) 5710A and 5713A HV Generator.
5. Having performed checks 1 to 4 above, select Diagnostics|Detectors (page 5-27); perform a 10 second count and check the faulty channel(s). Make note of the counts.

Zero counts in a channel usually implies a complete failure in either the 5710A detector or HV/Amplifier PCB. A few counts suggests either reduced detector efficiency or threshold problems in a gas flow amplifier or HV/Amplifier.

6. Swap the gas flow HV cable to a working channel if possible. Perform a further 10 second count and note the counts in each channel.
7. If the fault moves with the detector into a previously working channel, the fault is in the detector cable assembly and this should be replaced.
8. If the fault remains with the original gas flow channel, the fault is in the 5710A counter and this should be replaced, using the pre-gassed “hot spare” if available.
9. For iPCM12C gamma options, swap the faulty scintillation detector MHV connection from the relevant HV/Amplifier to that of a working channel. Perform a further 10 second count and note the counts in each channel.
10. If the fault moves with the detector into a previously working channel, the fault is in the detector assembly and should be replaced as defined in FHT681 - Removal and Replacement (page 11-13).
11. If the fault remains with the original HV/Amplifier channel, the fault is in the HV and Amplifier PCB and this should be replaced as defined in FHT681 - Removal and Replacement (page 11-13).

Will Not Run and Displays "Out Of Service – High Background Conditions"

This condition occurs when the Background activity prevents the iPCM12 from discriminating the pre-set alarm levels (α and β for gas flow detectors, and γ for gamma option) with the required confidence within the Maximum Monitoring Time allowed. It may be necessary to consult Health Physics for clarification.

Enter a valid password and proceed as follows:

1. Select Setup |Monitoring (page 5-14) and check that the Maximum Monitoring Times are set to reasonable values. Adjust upwards if necessary.
2. Select Setup |Alarms (page 5-19) and check that the Normal Alarm levels are set to reasonable values. Adjust upwards if necessary.
3. Select Setup |Detection Options (page 5-17) and check that the Probability of False Alarm is set to a reasonable value. Typically 3.1σ. Reduce if necessary.
4. Select Setup |Detection Options (page 5-17) and check that the Probability of Detection is set to a reasonable value. Typically 1.65σ. Reduce if necessary.
5. Select Calibration HV Scan (page 5-46). Check that the High Voltage setting for the gas flow detectors (α and β

selection) is correct – typically 1700V for P7.5 Argon/Methane gas. For gamma detectors (γ selection) if fitted, check the High Voltage settings of ALL eight detector channels are correct – typically ranging from 800 V to 1100 V.

6. Select Setup |Monitoring (page 5-14) and set a 10 second Minimum Monitoring Time. Check the counts in all gas flow detector channels and all scintillator channels are reasonable for the expected ambient background level using Diagnostics|Detectors (page 5-27).
7. If a single channel shows a background count significantly greater than the other detectors, a noisy channel (or a scintillator light leak) is likely. Proceed as follows:
8. Swap the faulty gas flow detector for the pre-gassed "hot spare". It will be necessary to enable the replacement detector node/address (α / β) – see XChannel (page 5-20).
    - Swap the faulty scintillation detector MHV connection from the relevant HV/Amplifier to that of a working channel. Perform a further 10 second count and note the counts in each channel. *(Keep the different operating voltages in mind).*
    - If the scintillator fault moves with the detector into a previously working channel, the fault is in the detector assembly and should be replaced as defined in Scintillation Detector Removal and Replacement (page 11-21).
9. If the scintillator fault remains with the original HV/Amplifier channel, the fault is in the HV and Amplifier PCB and this should be replaced as defined in FHT681 - Removal and Replacement (page 11-13).
10. If all channels show a background count significantly greater than expected, the iPCM12 is experiencing an elevated background. Proceed as follows:
    - Check the area immediately around the iPCM12 for sources of any possible contamination.
    - Measure the ambient background level with a suitable survey monitor. If the background is high, it must be reduced or the iPCM12 moved for normal monitoring operation to resume.

IF THIS CONDITION PERSISTS and the background and measurement limits seem to be reasonable, 'frisk' inside the monitor cubicle for a possible build-up of contamination.

Fails Lamp or LED Tests

A power-on Self Test lights each lamp and LED in turn. If any lamp or LED fails to light in sequence (except the charging LED), proceed as follows - using Diagnostics|Lamps (page 5-34) to re-test lamps as required:

1. Check the connections to the lamp assemblies and to the 5712A processor board.
2. Any device failure will need a replacement board.
3. If there are two lamp assemblies and neither are functioning, then a fault on the processor board is indicated and it should be replaced as described in ETX Processor Motherboard Type 5712A - Removal and Replacement (page 11-10).

Fails Loudspeaker Test

A power-on Self Test produces a single chime "ding-dong" upon satisfactory completion. If no sound is heard, proceed as follows:

1. Enter a valid password and select System|Setup (page 5-79); increase the volume. The speaker should produce a series of "beeps" that gradually get louder or quieter when the volume control is dragged.
2. If no sound is heard, check the speaker connection to the processor board.
3. Since the speaker is unlikely to have failed, a fault on the Controller board is indicated and it should be replaced as described in ETX Processor Motherboard Type 5712A - Removal and Replacement (page 11-10).

Fails the LCD Display Test

A power-on Self Test switches on the back-light and produces a series of "Self Test Messages and "beeps". If the display fails to show any message or is totally "blacked out", proceed as follows:

4. Check the multi-cable connections from the display to PL6 and PL7 on the processor board 5712A.
5. If check 1 above has not revealed the problem, a fault in the LCD module or Controller board 5691A is indicated.
6. Temporarily connect a spare LCD module to the Controller board PL6 and PL7 (the back-light is required).

If the message becomes visible, the fault is in the LCD display module. This is not user serviceable and should be replaced (with the back-light) as described in LCD Display, Touch

Screen, Touch Controller, and Backlight Inverter - Removal and Replacement (page 11-15).

If no message appears, the fault is in the processor board, which should be replaced as described in ETX Processor Motherboard Type 5712A - Removal and Replacement (page 11-10).

Display Backlight Failure

A power-on Self Test switches on the back-light and produces a series of "Self Test Messages" and "beeps". If the back-light fails to light, proceed as follows:

1. Check the cabling from the back-light inverter enclosure to PL7 on the processor board.
2. Verify that five volts appear across the pins of PL7 when the back-light should be on. If 5 volts is apparent, then a fault in the LCD or back-light inverter is indicated. These items are not user serviceable and should be replaced as described in LCD Display, Touch Screen, Touch Controller, and Backlight Inverter - Removal and Replacement (page 11-15).
3. If the voltage is absent across the pins of PL7, a fault on the Controller board is indicated and it should be replaced as described in ETX Processor Motherboard Type 5712A - Removal and Replacement (page 11-10).

Will Not Accept Valid Passwords

If the iPCM12 starts and runs but will not accept a valid password, a fault is indicated either in the LCD Touch-pad or the Controller board. Proceed to LCD Keypad Inoperative or Not Aligned (page 11-33).

LCD Keypad Inoperative or Not Aligned

If the iPCM12 starts and runs but will not respond to password entry or returns incorrect characters on the LCD display, a fault is likely in the processor board or possibly the touch keypad. Proceed as follows:

1. Check the cable connections between the Touch screen keypad and the processor board. If uncertain, try a replacement cable to isolate fault.
2. Similarly, check the touch control board by replacement.
3. If unsuccessful, temporarily plug a spare LCD assembly into the control board. If this solves the problem the original Touch-pad is faulty and should be replaced as described in LCD Display, Touch Screen, Touch Controller, and Backlight Inverter - Removal and Replacement (page 11-15).

4. If the problem still persists the fault is likely to be in the 5712A board, which should be replaced as described in Replacement of the ETX (page 11-10).

Will not Enter Background Mode Or Locked in Background Mode

If, after power-up or after exiting from the main menu the iPCM12 displays "Cannot Measure Background - Please Exit the Portal", a fault with the Infra Red links is likely. Proceed as follows:

1. Ensure that the Links are working correctly by selecting "Diagnostics/Sensor". The switch and links can be tested for correct operation.
2. Check the continuity of the cable connecting the Sensor(s) to the adjacent 5710A detector boards.
3. Replace the processor board as described in ETX Processor Motherboard Type 5712A - Removal and Replacement (page 11-10) if the switches are working correctly.

Locked in Measurement Mode

If the iPCM12 becomes stuck in a monitoring cycle with the display showing "Count Time Remaining xx seconds" it is likely that microprocessor has crashed. Power down and check again. Continual crashing may indicate that the processor board needs to be replaced as described in ETX Processor Motherboard Type 5712A - Removal and Replacement (page 11-10). It is possible that the hard disk may have suffered some damage in this area of the program. If the problem persists even after changing the processor board, a new disk should be considered.

USB Output Data Is Corrupted

If USB data output from the iPCM12 to a serial printer or external computer contains spurious characters or is corrupted in any way, check the following possible causes:

1. If no output whatsoever is received, check the data cable connections (see Displays (page 3-15)).
2. If a USB printer is involved, perform a printer self-test, to determine whether the printer itself is at fault.

The following section applies to Door and Barrier options only.

Barriers will not OPEN/ CLOSE - Unreliable Door Operations

If the entry Barrier fails to Close UP or DOWN, then select the Diagnostic/Barriers (page 5-23) function to exercise the arm. Should this be successful, then check that the front barrier has been Enabled and Closed for one of the three options.

If un-successful, then it will be necessary to verify that power is reaching the motor by examining the voltages on the motor connector when it is asked to close/open (see Barriers (page 5-23)). If power exists, examine the motor assembly to decide whether the motor itself is at fault or the integral microswitches are damaged/ misaligned.

If no problem is found with the motor assembly and its cabling, then suspect the GPIO card. Replacing the 5707A GPIO Board should resolve the fault.

NOTE: IT IS IMPORTANT THAT THE USER LEAVES THE DOOR IN A CLOSED POSITION; OTHERWISE THE CONTROL PANEL OR OPERATION FROM THE iPCM12 APPLICATION WILL BE INHIBITED. SIMILARLY, IF IN DIAGNOSTICS AND THE DOOR IS OPENED, OPERATION FROM THE CONTROL PANEL IS RESTRICTED.

Chapter 12 Recommended Spares List

The following spares are recommended on the basis that **first-line service** is best performed on iPCM12A by changing modules:

ETX CONTROLLER BOARD, COMPLETE W/PROCESSOR, HDD, and FLASH MODULE	D92615/A
DC/DC CONVERTER BOARD	5714C
QUAD GAS FLOW DETECTOR	5710A
ETX PROCESSOR**	702964PB
SECURITY DONGLE	A92169/D
BATTERY CONTROLLER BOARD	5703A
GAS FLOW CONTROL BOARD	5709A
LCD ASSY COMPLETE W/TOUCH SCREEN, CONTROLLER, and INVERTER	D92583/A
POWER SUPPLY MODULE 150W	702947KJ
KEYSWITCH	11705234
GUIDANCE DISPLAY BOARD	5711A
PHOTOSENSOR RX/TX PAIR	702260ND
5 WAY LED CLUSTER BOARD	5672A
PANEL LOCK & KEY	A92452

Spares List – Basic Components (iPCM12A)

LCD ASSY COMPLETE W/TOUCH SCREEN, CONTROLLER, and INVERTER	D92583/A
GAS FLOW CONTROL BOARD	5709A
DC-DC CONVERTER	5714C
REPLACEMENT HDD + OPERATING SYSTEM	A92083/A
5-WAY LED CLUSTER	5672A
GUIDANCE DISPLAY	5711A
BATTERY CONTROLLER BOARD	5703A
BATTERY TEMPERATURE SENSOR	5659B
HV GENERATOR BOARD	5713A
QUAD GAS FLOW DETECTOR	5710A
QUAD GAS PROPORTIONAL AMP BOARD	5704A
QUAD GAS FLOW WINDOW FOIL ASSEMBLY	B92412/A
PHOTOSENSOR RX/TX PAIR	702260ND
GUIDANCE DISPLAY BOARD	5711A
5 WAY LED CLUSTER BOARD	5672A

SECURITY DONGLE	A92169/D
PANEL LOCK & KEY	A92452
SEALED BATTERY	503073KJ
LOUDSPEAKER	11705242
POWER SUPPLY MODULE 150W	702947KJ
COMPACT FLASH W/PROGRAM & OS	702275KM
HEX TREADPLATE	C92479
KEYSWITCH	11705234

Spares List – Optional Components

iPCM12B or C with gamma option only	HV & AMPLIFIER BOARD (FHT681)	FHT681425430223
iPCM12B or C with gamma option only	HAND, FOOT, SHOULDER SCINTILLATION DETECTOR	5708A
iPCM12B or C with gamma option only	BODY SCINTILLATION DETECTOR	5717A
iPCM12B or C with doors or barrier	GPIO CARD	5707A
iPCM12C only	DYNODE CHAIN	A3/54040
iPCM12C only	PHOTOMULTIPLIER TUBE	B35246
iPCM12C only	GPIO CARD	5707A
iPCM12B or C with gamma option only	DYNODE CHAIN	A3/54040
iPCM12B or C with gamma option only	PHOTOMULTIPLIER TUBE	B35246
iPCM12B or C with barrier option	BARRIER ARM MOTOR	702847JB
iPCM12B or C with barrier option	BARRIER ARM (Red/White)	11705321
iPCM12B or C with door option	DOOR OPERATOR DFA127	12708334
iPCM12B or C with door option	DOOR SLIDE ARM	127808183
iPCM12B or C with door option	DOOR POWER SUPPLY NET127	127808165
iPCM12B or C with door option	DOOR PROCESSOR MODULE DFA127	127808231
iPCM12B or C with door option	DOOR CONTROL U NIT BDE-D	903808321
iPCM12B or C with door option	DOOR SIDE CAP WITH BDI SWITCH	127808171
iPCM12B or C	DOOR SIDE CAP BLANK	127109451

with door option		
iPCM12B or C with door option	BUTT HINGE HEAVY DUTY st/stl	Details on request

Available Spare Parts Kits

PART NUMBER	ITEM DESCRIPTION	QTY	BASIC KIT	ENHANCED KIT	GAMMA OPTION KIT
SPAREKIT BIPCM12	BASIC SPARE PARTS KIT		X		
SPAREKIT EIPCM12	ENHANCED SPARE PARTS KIT			X	
SPAREKIT CIPCM12	IPCM12C SPARE PARTS KIT (GAMMA OPTION)				X
11705234	KEY SWITCH	1	X	X	
5659B	BATTERY TEMPERATURE SENSOR	1	X	X	
5672A	5 WAY LED CLUSTER BOARD	1	X	X	
5703A	BATTERY CONTROLLER BOARD	1	X	X	
5704A	QUAD GAS PROPORTIONAL AMP BOARD	1	X	X	
5709A	GAS FLOW CONTROL BOARD	1	X	X	
5710A	QUAD GAS FLOW DETECTOR	1	X	X	
5711A	GUIDANCE DISPLAY BOARD	1	X	X	
5713A	HV GENERATOR BOARD	1	X	X	
5714C	DC/DC CONVERTER BOARD	1	X	X	
702260ND	PHOTOSENSOR RX/TX PAIR	1	X	X	
702947KJ	POWER MODULE 150W	1	X	X	
A92169/D	iPCM12 SECURITY DONGLE	1	X	X	
A92452	PANEL LOCK & KEY	1	X	X	
B92412/A	QUAD GAS FLOW WINDOW FOIL ASSEMBLY	20	X	X	
503073KJ	SEALED BATTERY	1		X	
D92583/A	LCD ASSEMBLY	1		X	
D92615/A	ETX PROCESSOR ASSEMBLY	1		X	
5708A	GAMMA SCINTILLATION DETECTOR HAND & FOOT	1			X
5717A	GAMMA SCINTILLATION DETECTOR BODY	1			X
B92763/J	CABLE ASSY MHV/MHV 8 METERS	2			X
FHT681 425430223	FHT681 GAMMA CHANNEL AMPLIFIER	1			X

Accessories List

CALIBRATION FIXTURE ALPHA (^{241}Am) – 2 SOURCES	AE0246A
CALIBRATION FIXTURE BETA (^{137}Cs) – 2 SOURCES	AE0247A
CALIBRATION FIXTURE BETA (^{36}Cl) – 2 SOURCES	AE0247B
CALIBRATION FIXTURE BETA (^{99}Tc) – 2 SOURCES	AE0247C
CALIBRATION FIXTURE GAMMA (^{137}Cs)	Details on request
CALIBRATION FIXTURE GAMMA (^{60}Co)	Details on request
SECURITY DONGLE	A92169/D
GAS FLOW SIDE OF FOOT KIT	AE0221A
GAS FLOW HEAD DETECTOR KIT	AE0223A
SCINTILLATION HEAD DETECTOR KIT	AE0224A
GAMMA SCINTILLATION DETECTOR KIT	AE0222A
SPARE PURGED DETECTOR KIT	AE0229A
ENCLOSED CABINET INLET BARRIER KIT	AE0237A
ENCLOSED CABINET DOOR LH/RH KIT	AE0238A
ENCLOSED CABINET LH SWING DOOR KIT	AE0239A
ENCLOSED CABINET RH SWING DOOR KIT	AE0240A
CAMERA KIT	AE0227A
USB BARCODE READER	AE0244A

Chapter 13 Drawing Appendix

The following pages provide the drawings listed below.

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	OUTLINE DRAWING – iPCM12A	D92620/A
5713A	HV GENERATOR	E92359/A
5659B	TEMPERATURE SENSOR BRD	C91794/B
5703A	BATTERY CONTROLLER BRD	D92313/A
5672A	5-WAY LED CLUSTER	D91956/A
5714B	DC-DC CONVERTER BOARD	C92356/A
	ETX PROCESSOR ASSEMBLY	D92615/A
5712A	ETX PROCESSOR BOARD	E92353/A
	GAS CONTROL CHASSIS	D92610/A
5709A	GAS FLOW BOARD	E92362/A
5711A	GUIDANCE DISPLAY BOARD	C92349/A
5707A	iPCM12C GPIO CARD	E92343/A
5710A	QUAD GAS FLOW DETECTOR ASSEMBLY	D92413/A
	iPCM12A INTERCONNECTION DIAGRAM *(See diagrams at back of document)*	D92591 [6 sheets]
	iPCM12A GENERAL ASSEMBLY DRAWING	D92590/A
	iPCM12B GENERAL ASSEMBLY DRAWING	D92767/A
AE0222A	AE0222A GAMMA KIT	D92513A
	SCINTILLATOR CENTRE CALIBRATION POSITIONS	D92842
	IPCM12B/C ENCLOSED UNIT FAMILY TREE	C92675
	IPCM12 SERIES OUTLINE DRAWING	D92620 (2 sheets)
	MATERIAL SAFETY DATA SHEET AIRGAS	P-10_MSDS

Chapter 14 Glossary of Terms

µCi	micro-curie
A	Attenuation Factor or amps
AE	Associated Equipment
AL	Alarm Level
BAE	Body Average Efficiency
Beff	Effective Background while Monitoring
Bq	Becquerel
Bsum	Total Average Background Count Rate
C	Counter(s)
CAct	Contamination Alarm Level
CCM	Cobalt Coincidence Monitoring
Ccps	Contamination Alarm Count-rate
Ceffect	Effective Alarm Count rate
Ci	Curie
CPM	Counts per minute
D	Door(s)
DL	Detection limit
dpm	Disintegrations per minute
E	Efficiency Correction Factor
Egress	Act of Exiting
EPD	Electronic Personal Dosimeter
ETX	Embedded Technology Extended
F	Probability of False Alarm
FOM	Figure of Merit
GPIO	General Purpose Input/Output
Health Physicist	Person, Persons or Team responsible for setting up day-to-day running and maintenance of the LAM12
HP	*Health Physicist*
HV	High Voltage
IEC	International Electrotechnical Committee

Ingress	Act of Entering Keyboard Emulating Id Provider
kBq	kiloBecquerel
Keyboard Emulating Id Provider	Another term for USB Barcode Reader
L	Lead
LAM	Large Articles Monitor
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LVD	Low Voltage Directive
MAct	Minimum Detectable Activity
mCi	Milli Curie
MDA	Minimum Detectable Activity
NBR	Natural Background Reduction
NE110 equivalent	Term referring to a specification of plastic
nCi	nanocurie
NORM	Naturally Occurring Radioactive Material
P	Probability of Detection
PCB	Printed Circuit Board
pCi	picocurie
PFC	Personnel Flow Control
PM	Personnel Monitor or Portal Monitor
PMT	Photomultiplier Tube
PoFA	Probability of False Alarm
PSU	AC mains Power Supply
Quickscan	Method used to identify, within the monitoring time (see Tmon), whether the article is either “clearly” contaminated or clear, referred to as “real-dirty” or “real-clean”
RAct	Activity of Contamination
RCC	Residual Contamination Count
SAM	Small Article Monitor
Technician	Personnel who normally repair and maintain the instrument in working condition
tB	Background Update Time
Tcal	Calculated Monitoring Time
ThermoFisher	Personnel who are general users of the system and normally carry out routine diagnostic and test functions
Tmax	Maximum Monitoring Time

Tmin	Minimum Monitoring Time
Tmon	Actual Monitoring Time
User	Anyone associated with or operating the instrument.
V	Voltage

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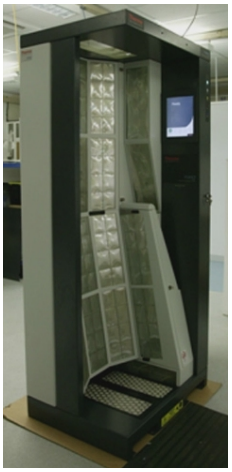
MANUAL-iPCM12

INSTALLED PERSONNEL CONTAMINATION MONITOR

Thermo Fisher Scientific

iPCM12

24th July 2009



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NOTICE

iPCM12

WARRANTY AND LIABILITY

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IMPORTANT NOTICE

All units produced after the 1st January 1996 must by law conform to the rules and regulations governing Electro-magnetic compatibility (EMC). In order to meet the requirements and CE mark the units described in this manual, any maintenance carried out must ensure the correct re-assembly of all parts, especially the earth straps. Furthermore, particular attention should be made to the correct mounting of the mains filter.

WARNING

Personnel may trigger an alarm on a iPCM12, who have recently been subject to radiotherapy treatments that involve the injection or ingestion of radioactive isotopes. The monitor is not able to distinguish these isotopes from those generated via on on-site process. However the monitor does have the ability to indicate the presence of low energy photon emitting isotopes, which are typical of radiotherapy treatments.

The iPCM12 monitor should be primarily used for monitoring personnel. Other objects and articles should be monitored with a monitor that is designed for their monitoring, such as a SAM12.

However if articles are passed through the monitor, operational procedures should contain warnings regarding inappropriate articles.

These items may include:

- Articles containing liquids
- Articles with significant shielding
- Articles containing large magnets
- Articles with known radioactive content

Articles containing liquids may have different release criteria. Articles of large weight or significant shielding may require different procedures requiring Health Physics intervention. Articles with a magnetic pull of more than four pounds may influence the accuracy of the monitor.

The iPCM12 weights between 0.75 and 1 tonne. The monitor should only be installed and used on a suitably robust and stable base. The monitor should never be moved with the lead installed.

WARNING AGAINST IMPROPER USE

The protection provided by this equipment may be impaired if used in a manner not specified by the manufacturer. The user must adhere to all the safety precautions noted overleaf and to individual warnings contained within this manual.

WARNING SYMBOLS:

The following is an explanation of the warning symbols seen on the iPCM12. Please read this information before using and/or maintaining this equipment.

As seen on the top of the iPCM12 frame and FHT681 covers.

	CAUTION: **Isolate the mains supply and wait one minute before removing this cover.**

	CAUTION: **Isolate HV supply to the printed circuit board before removing cover. With power connected and unit switched on, a max. voltage of +1500V DC with a maximum short circuit power of 825 milliwatts is present.**

	CAUTION: **Risk of electric shock.**

WEEE COMPLIANCE:

This product is required to comply with the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive 2002/96/EC. It is marked with the following symbol:

Thermo Fisher Scientific has contracted with one or more recycling/disposal companies in each EU Member State, and this product should be disposed of or recycled through them. Further information on Thermo Fisher's compliance with these Directives, the recyclers in your country, and information on Thermo Fisher products which may assist the detection of substances subject to the RoHS Directive are available at www.thermofisher.com/WEEERoHS

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Manual Revision History

Issue	Date	Name	Section(s)	Revision comments	Approval
Issue 1.0	July 2009	C Hills	All	Initial Release	M Pottinger

Foreword

Throughout this document the term **“HEALTH PHYSICIST”** (HP) is used extensively. It refers to the Person, Persons or Team responsible for setting up day-to-day running and maintenance of the **iPCM12**. This may be an Instrument Maintenance Engineer, Radiation Safety Officer, local “Competent Person”, Departmental Manager or any other Responsible Person. The **“HEALTH PHYSICIST”** is the highest-level security role, uniquely responsible for setting and maintaining all lower order passwords. The HP would normally be responsible for installing and setting up the **iPCM12**, calibrating for user-defined nuclides, programming operating parameters and verifying correct operation of the instrument.

The term **“TECHNICIAN”** is used to refer to the personnel who normally repair and maintain the instrument in working condition. IMP personnel are designated to this role.

Personnel who are general users of the system and normally carry out routine diagnostic and test functions are allocated to the **“THERMOFISHER”** role.

The term **“USER”** refers to anybody associated with or operating the instrument in any way.

For more information on which menu options are available, see Menu Roles (page 5-6).

Chapter 1 Introduction

Installed Personnel Contamination Monitor

The iPCM12 (Installed Personnel Contamination Monitor) is a Gas Flow Alpha, Beta and (optional) Gamma whole body monitor based on the X-Channel platform. Its simplicity of operation reduces the amount of training necessary for users and maintenance personnel. An Annunciator Screen, audible prompts and configurable measurement types are used in conjunction with a back-lit touch-screen LCD and distinctive audible tones, to make controlled monitoring fast and simple.

The iPCM12 uses up to 23 quad detector gas flow detectors giving a maximum of 92 detector channels. Each channel will have 4 discriminator thresholds associated with it and 5 counter channels, one for each discriminator and an extra one for coincidence counting. Each gas flow detector will be serviced by a single XChannel board featuring 4 amplifier channels, one for each section of the detector.

The electronics are housed in a compartment on the right hand side of the instrument for easy maintenance.

Version "A" is the Open unit type and Version "B" is the Closed unit type.

Version "C" is the Closed unit type plus the Gamma option. This includes an additional 9 scintillation detectors, which are serviced by five FHT681 amplifiers as used in the PM12.

Measurement results are displayed on a portrait oriented LCD monitor.

The instrument is fitted with sensors which identify when the user enters or leaves the sensitive part of the instrument, and seven position sensors to determine when a user is in the correct monitoring position. When the instrument is occupied, the instrument suspends background updating and initiates the contamination survey. The alarming algorithm in the iPCM12 ensures the maintenance of a user selected Minimum Detectable Activity (MDA), regardless of background radiation level, by continually adjusting count time and verifying user residence time in the portal.

The instrument is available in open and closed variants with the closed variant featuring either powered or unpowered doors.

The instrument will utilise a two step measurement, with the user facing the detector array for the first step and then rotating 180 degrees to face away from the measurement array for the second step.

The instrument is provided with battery backup for continued operation in the event of a power failure.

The iPCM12 can have the following options in any combination:

iPCM12 Type			**Detector Types**	
Open Unit	A	available with	Basic Gas Flow used for $ArCH_4$, ArCo2 or N2 alpha	GF
Closed Unit	B		Gas sealed	GS
Closed Unit + Gamma option	C		Beta plastic	SC

The instrument build standard is therefore identified using the following nomenclature:

iPCM12*u* – *d* - *l*

where: *u* is Unit Type
d is Detector Type
l is additional suffix of which signifies the user language may also be used e.g. -DE for German speaking or -C for Chinese.

The following AE kits are also available

- AE0223A – Gas Flow Head detector kit
- AE0221A – Gas Flow, Side of Foot detector kit
- AE0229A – Spare purged detector kit
- AE0224A - Top Head gamma scint kit
- AE0222A - Side head gamma scint
- EPD reader (either basic UserId or full exit reader)
- Barcode reader
- Pull down head detector (not yet available)
- Integrated Small Articles Monitor (not yet available)
- Multiple door and barrier options as follows:
  - Single powered door kit – left side
  - Single powered door kit – right side
  - Double powered door kit

  - Single manual door kit – left side
  - Single manual door kit – right side
  - Double manual door kit (not sure if this is a real option)
  - Barrier arm – left side
  - Barrier arm – right side
- Gas generator and power system
- Extended life power system

See Specification (page 3-1) for further information.

Features

- Two step operation (open and closed versions) – see Positioning (page 5-81).
- Statistical alarming algorithm with several selectable parameters including MDA, confidence level, false alarm rate and shielding factors – see Setup Menu (page 5-8).
- Large status indicator lights representing READY/CLEAR, RECOUNT, COUNT, ALARM and OUT OF SERVICE as well as chime and voice instructions – see Five Light System (page 5-68).
- Identification of which detector alarmed (with lights) is displayed on the monitor – see Detector Indicator (page 5-68). Low level distributed contamination is indicated by a separate light.
- Battery backup for 6 hours – see Battery/Mains Supply Indicator (page 5-101).

Chapter 2 Description

Basic cabinet assemblies

iPCM12A - Open booth Type 5715A

iPCM12B - Closed booth Type 5719A

iPCM12C - Closed booth with doors Type 5719A

Optional AE0222A gamma kit

The basic iPCM12A open booth cabinet 5715A is manufactured from a sturdy fabricated steel construction which contains the brackets required for attaching the gas flow detectors and electronics.

The basic iPCM12B closed booth cabinet 5719A contains the brackets required for attaching the gas flow detectors and electronics plus the optional gamma detectors and lead shielding.

The closed booth iPCM12C has additional mounting frames and adaptors to support the power door option.

Mounted within the right hand side of the main frame, is the Electronics Display Chassis (containing the ETX processor 5712A, 5713A HV generator, 5714B DC/DC Converter, Gas control chassis with 5709A gas controller, the LCD and touchscreen.

Under the LCD display is an (optional) EPD reader and access is provided for four USB sockets.

A network connector is provided at the top plinth.

Operational lamps are fitted on the front & side faces, and a numerical two digit count-down status display is fitted on the internal left side.

The main power input is from the top of the portal to an IEC connector. An isolator (accessed behind the right hand panel door) has also been provided for removing power from the equipment.

The right hand panel door also provides service access to the main electronics chassis, processor, HV generator, PSU, battery controller and battery. Refer to Drawing D92591 Sheet 1 (see Recommended Spares List (page 12-1)).

For iPCM12 variants with gamma scintillation detectors, the right hand panel door also provides access to the HV & amplifiers and HV cabling.

Two box sections are mounted in the base of the frame and run from front to rear. These box sections provide access for a Fork Lift truck; alternatively a long reach pallet trolley.

PLEASE REFER TO UNPACKING AND INSTALLATION (page 4-1) FOR THE LIMITATION ON THE USE OF THESE CHANNELS.

Warning: the iPCM12 has a high centre of gravity and must never be moved by pallet or forklift over rough or sloping surfaces or ramps.

Note that the iPCM12 version without LEAD can only be moved using fork lift or pallet. All units containing lead must be dismantled and the lead removed before manoeuvring the cabinet.

Electronics display chassis D92520/A

The Electronic display chassis (comprising of gas control chassis, ETX processor, HV generator, DC/DC convertor and LCD), is mounted within the main corner assembly of the iPCM12 frame. The upper gas chassis is retained by 4 hex pillers and studs. The ETX board is retained by 6 x M5 pillars, and provides access to the LCD, which may be removed to facilitate maintenance. The whole electronics chassis is retained by 10 x M6 pillars.

Main processor board - Type 5712A

The Controller Board, type 5712A, is motherboard to an ETX-PM(C) 1.5GHz Processor.

The ETX assembly provides PC functionality with 512Mb of RAM and the real time clock.

The motherboard interfaces directly to all other boards and external devices in the system via numerous connectors (not all are being used):

- The application software is retrieved from a 30 gigabyte (minimum) hard disk drive via SK10. The drive also provides non-volatile storage for all data.
- PL15 provides a flash card storage medium for long term storage of important data
- 4 x USB connectors on SK4, 11, 15, 16. SK4 is connected to the router on the user interface panel on the underside of the LCD display
- 1 x network interface SK201 routed to the user interface panel on the top of the main frame
- 1 x CRT monitor connection on SK3 (not used)
- 1 x LCD drive on PL6 with backlight driver on PL7

- 1 x RS232 driver for LCD touch screen on PL2
- 1 x POWER connector PL10
- 1 x Loudspeaker connection for sound generator on PL1
- 1 x connector on PL9 for communicating with LED cluster display
- 1 x X-channel software interface on SK1,6,7,8,13 & 14 for detectors, sensors, gas control, HV generator
- 1 x guidance display drive on PL8

X-Channel GPIO Board Type 5707A

Used in iPCM12C variants.

This card provides the necessary drive and monitoring circuitry required for controlling doors and barrier arm motors. Communication with the card is established via the "X-Channel" bus picked up from the nearest HV & Amp assembly.

When fitted, 5707A is fitted adjacent to the HV generator module on the lower part of the electronics display chassis.

Wiring and cabling is specific to the use of the monitor with doors, barriers or external turnstile controls.

Battery Controller Board Type 5703A

The Battery Controller Board, type 5703A, manages the charging of a 12 volt sealed lead-acid battery. The whole electronics system is powered from the 5703A board, which constantly senses the charge/discharge state of the battery and controls the charging voltage accordingly. The charging voltage is temperature compensated by means of a thermistor located on the battery, helping to maximise the life time of the battery.

A momentary key-switch, located on the front of the right hand panel, allows power to be switched to the electronics provided the battery voltage is above a safe value (i.e. not discharged), even when mains power is absent. The key-switch needs to be held ON for at least two seconds before the ON state is engaged.

The 5703A continues to monitor the terminal voltage of the battery during battery operation but will signal a shut-down if the battery discharges to a predetermined point, beyond which, it would suffer permanent damage and be difficult to recharge. A miniature fuse protects against over-current conditions.

The application software would normally regulate shut-down. In the event of the software losing control an emergency shut-down is possible by holding the key-switch ON for a minimum of 10 seconds (nominal).

DC-DC Converter Board Type 5714B

A proprietary DC-DC Converter pair produces regulated +5V and ±12V which outputs via the Battery Controller Board, type 5703A.

Scintillation HV and Amplifier Type 42543-0223 (FHT681)

Used in iPCM12C variants.

The Scintillation HV and Amplifier Board, type 1, is a dual channel high voltage generator/scintillation amplifier pair. The HV generators are sub-assemblies (type 42543-0202) which are controlled by DACs (Digital to Analogue Converter) on the main pcb. The HV has a range between 0 and 1400 Volts, with a resolution of about 1 Volt.

The charge pulses arriving along the high voltage cable from the scintillation detectors are amplified and each fed to five discriminators and five associated counters, all controlled by the microprocessor on the main board.

The cards are interrogated via the X-channel bus to retrieve counter values generated every 100ms from a 5 second buffer.

Annunciators Type 5711A and 5672A

These assemblies provide the front/side and internal left visual displays necessary to inform the user of progress through the instrument. Two cards are involved, namely the 5672A with 5 led clusters, and the 5711A with 2 led clusters and a numeric display counter

Scintillation Detectors Type 5708A & 5717A

Used in iPCM12B and iPCM12C fitted with gamma option kit AE0222A

Each of the six body detectors, type 5717A, is large area plastic rhomboid shaped scintillators wrapped in foil and plastic. Additionally, three rectangular scintillation detectors, type 5708A, are used for hand, foot and head monitoring.

A photomultiplier tube is hydrostatically embedded into each plastic scintillator. Connection to the dynode chain assembly, mounted on the back of the tube, is via a light-tight gland. A single coaxial cable provides high voltage for the tube and carries the signals to the HV and Amplifier PCB via an MHV connector. For further information, see Detectors (page 3-4)

Chapter 3 Specification

The standard iPCM12 (with lead liners) is available with the following options, in any combination:

- Unit Types:
  - Open
  - Closed
  - Closed + Gamma options
- Detector Types:
  - Basic Gas Flow used for ArCH4, ArCO2 or Air alpha
  - Gas flow with variation for Air beta
  - Gas Sealed (not yet available)
  - Beta plastic (not yet available)

The following AE kits are available for the above options:

Unit Type:	Open	Closed
Top Head Gas Flow	√	√
Side Foot Gas Flow	√	√
Spare Purged Detector	√	√
Top Head gamma scint	√	√
Side Head gamma scint		√
EPD Reader	√	√
Barcode Reader	√	√
Pull-down Head Detector	√	√
Integrated Small Articles Monitor		√
Multiple door and barrier options		√
Gas Generator and Power system	√	√
Extended life power system	√	√

Operational Parameters

See Monitoring (page 5-12) for information regarding the settings and defaults for the Operational Parameters.

Software Options

See UI Options (page 5-8) and Operation (page 5-10) for information regarding the settings and defaults for the Software Options.

Default Messages

See Messages (page 5-24) for information regarding the settings and defaults for the Software Options.

Background Capability

Background capability is related to alarm threshold and statistical certainty requirements. Alpha and Beta/Gamma background subtraction is included in the Monitor's measuring routines.

When any of the Operational Parameters are changed, the monitoring time required will be automatically reassessed in relation to the measurement certainty required and the prevailing Background conditions. Since the gas flow detectors have a high gamma rejection, the operational Background limit will be dictated by the scintillation detector count rates and proportional to the amount of shielding employed where the gamma monitoring option is fitted.

An "Out of Service – High Background" indication is given if backgrounds exceed levels required for correct operation. Under these conditions, the background must either be reduced to an acceptable level, or the alarm levels and/or measurement certainties required must be relaxed.

A Background Attenuation factor facility is provided. This factor compensates for the attenuation and/or scatter of background radiation caused by an operator when in the monitoring position.

For Alpha and Beta Backgrounds, monitoring will be based over a 100 second count in 10 second blocks, which is maintained on a "rolling average" basis. For Gamma Backgrounds, monitoring will be based over one second check periods, each one second period will contribute to a rolling average of up to 100 periods.

A significant change in the measured background count rate from the mean will cause the iPCM12 to discard the current mean value and restart background monitoring (see Changing Background (page 6-13)).

If, due to continuous operation, the iPCM12 has been unable to measure background for 15 minutes, a 10 second background count is performed immediately after the current monitoring sequence. If no significant change is detected, the machine will be available for further monitoring. If a change in background is detected, further background measurements are performed until the iPCM12 detects a stable background (see Changes to the Normal Background Monitoring (page 5-76)).

When the mandatory 100 second background count has been accumulated, the monitoring time required to achieve the specified alarm level is calculated. Providing the monitoring time calculated falls within the maximum and minimum limits (see Monitoring (page 5-12)), the instrument will be ready for monitoring. If, however, the monitoring time calculated is greater than the maximum allowed, a "high background" condition exists and monitoring will be inhibited.

A high background condition indicates that the alarm level set and statistical certainties required are not achievable, under the current background conditions. This may be overcome when either the background falls or more suitable operational parameters are entered by the Health Physicist. It is advisable to check for residual contamination if this occurs unexpectedly or persists.

The lower the background field, the more sensitive, stable and accurate the measurements will be.

A Background Attenuation factor facility is provided. This factor compensates for the attenuation and/or scatter of background radiation caused by an operator when in the monitoring position.

Detectors

The alpha/beta detectors in the standard iPCM12 are Gas Flow Proportional counters. All detectors with the exception of the foot detectors are fitted with:

either the standard rugged with a square pattern grille and an open area of 50%;

or an optional high efficiency heaxagina patter grille with open area of 65%.

Optionally, additional gamma sensitive Plastic Scintillation counters may be fitted. The counts from every detector in the system are routed back to the main controller where they are processed individually.

Gas Flow Proportional Counters

All Gas Flow Proportional counters have Quad Amplifier and Discriminators type 5704A attached. All Gas Flow counters have the following common data.

Operating Voltage:	1850 V for 5% Methane in Argon
(at Sea level)	1900 V for 7.5% Methane in Argon - recommended*
	950 V for 10% Methane in Argon
	2000V for 10% Co_2 in Argon
	100V for 20% Co_2 in Argon
Window Material:	Single Mylar sheet aluminised both sides.
	Standard weight is 0.9 mgm/cm^2

NOTES

- *All gas flow efficiencies are Typical for P7½ gas @ 1900V & sea level.
- Efficiency variations up to ±10% are possible for beta contaminants
- Efficiency variations up to ±15% are possible for alpha's where manufacturing tolerances are more critical.
- Please read note regarding Detector Maintenance in Maintenance and Trouble Shooting (page 11-1)
- Depth dimension includes head amplifier unit and gas connections
- Working voltages may be reduced by 200V at 8,000 feet above sea level.

Gas Flow Counter 5710A (21 per IPCM12)

Overall Dimensions:	466.5 x 181 x 25 mm	
Active Area:	455.5 x 160 mm (728 cm²)	
Gamma Response:	approx. 60 cps in a uniform field of 1µSv/h due to 660 keV photons	

Typical performance to sources with 150 cm^2 of traceable surface emission rate placed in contact with the Array Grille.

	Standard Rugged Grille	
Alpha Efficiency: (% of SER)	Americium-241	28%
Beta Efficiency: (% of SER)	Carbon-14	22%
	Cobalt-60	31%
	Chlorine-36	37%
	Strontium/Yttrium-90	39%
	High Efficiency Grille	
Alpha Efficiency: (% of SER)	Americium-241	40%
Beta Efficiency: (% of SER)	Carbon-14	30%
	Chlorine-36	50%

Gas Flow Foot Counter type 5710A (2 per iPCM12)

Overall Dimensions:	466.5 x 181 x 25 mm	
Active Area:	455.5 x 160 mm (728 cm²)	
Gamma Response:	approx. 60 cps in a uniform field of 1µSv/h due to 660 keV photons	

Typical performance to sources with 150 cm^2 of traceable surface emission rate placed on Foot Plinth Tread Plate. Window Support frame in contact with stainless steel foot grille.

Alpha Efficiency: (% of SER)	Americium-241	
Beta Efficiency: (% of SER)	Carbon-14 Cobalt-60 Chlorine-36 Strontium/Yttrium-90	25% 35% 43% 43%

Optional Plastic Scintillation Counters

Hand/Foot and Head

Type:	5708A
Construction:	Large area (rectangular cuboid) scintillation counter using a plastic phosphor type NE110 equivalent wrapped in foil and plastic.
Thickness:	2.25" (57 mm)
Area:	160 mm x 520 mm = 832 cm^2
Photomultiplier:	1" (25 mm) extended cathode
Shielding:	20 mm of aged lead on all external faces
Energy Response:	20 keV upwards (minimum detectable depends on liner material)

Body Array

Type:	5717A
Construction:	Large area (rectangular surfaces with a trapezoid profile) scintillation counter using a plastic phosphor type NE110 equivalent wrapped in foil and plastic.
Thickness:	2.25" (57 mm)
Area:	(largest surface) 325 mm x 550 mm =
Photomultiplier:	1" (25 mm) extended cathode
Shielding:	20 mm of aged lead on all external faces
Energy Response:	20 keV upwards (minimum detectable depends on liner material)

Overall Body Average Response

The “Body Average Efficiency” @ 50 mm (as defined by IEC 61098) is a useful measure:

Gas Flow Detector, Standard Grille, Beta BodyAverage Efficiency (Typical 4π)

^{36}Cl	(4π):	approx.	9.2% without summing
^{36}Cl	(4π):	approx.	11.5% with summing
^{60}Co	(4π):	approx.	5.5% without summing
^{60}Co	(4π):	approx.	6.8% with summing
^{14}C	(4π):	approx.	2.3% without summing

Gamma Body Average Efficiency

^{60}Co	(4π):	approx.	10% without summing
			16% with summing

Scintillation Detectors

HV settings

Operating voltages should normally be set up using the NBR method (page 9-8), although they may also be set up using the Figure of Merit (FOM) method for gamma scintillation detectors (page 9-8) to yield the operating Photomultiplier voltages. These settings are determined and set using the HV Scan feature (Calibration|HV Scan (page 5-41)). The recommended values, based on the NBR optimization method, can be found in the Calibration certificate for each individual instrument.

Energy Window

This can have all thresholds adjustable under software control:-

Programmable Threshold 1	0 - 4095mV in 1 mV steps
Programmable Threshold 2	0 - 4095mV in 1 mV steps
Programmable Threshold 3	0 - 4095mV in 1 mV steps
Programmable Threshold 4	0 - 4095mV in 1 mV steps
Programmable Threshold 5	0 - 4095mV in 1 mV steps

Control

Instrument ON/OFF operation is via a momentary key-switch on the side panel. Entering the portal activates a sensor and suspends background monitoring until the portal is vacated. Entering the portal indicates a user is ready to be monitored and initiates a time-out period (see Entering the Portal (page 5-78)). Exiting the portal during monitoring aborts the measurement (see Violations during Monitoring (page 5-83)). Data entry and diagnostic functions are accessed through a touch screen but access is password protected.

Displays

LCD

The integral back-lit LCD display provided is used in conjunction with the touch-screen for data entry and diagnostic functions. As well as duplicating any front panel LED display, the LCD can also provides comprehensive, user-friendly operational guidance, measurement results and instrument fault messages.

Lamps Five, bright, front and rear panel lamps show the instrument status at all times and give the user clear indication of the measurement result:

Green:	READY / CLEAR
White:	RECOUNT
Yellow:	COUNT
Red:	ALARM
Blue:	OUT OF SERVICE

Charging LED A steady green LED on the side panel indicating that the mains is on and charging the battery.

Audible Indications

Chime	Measurement with a CLEAR result
Single Dong	End of a parameter counting sequence. OR Measurement Aborted
Periodic Dongs	Operator sequence ERROR
Rapid Dongs	Measurement exceeding ALARM ACTIVITY
Two Tone	Measurement exceeding HIGH LEVEL ALARM
Warble	Measurement Aborted

In addition to the audible indications given above, the following voice prompts are given, if enabled (see UI Options (page 5-8)):

Enter identification.	If User ID Required is ticked, the user is requested to enter their ID before entering the portal (see User ID (page 5-79)).
Illegal Entry – Please leave the portal.	If User ID Required is ticked and the user enters the portal without entering their ID (see User ID (page 5-79))
Please return to position.	If during measurement, the user moves from the specified position (see Violations during Monitoring (page 5-83)).
Illegal Exit – Please re-enter the portal.	If the user exits the portal during measurement (see Violations during Monitoring (page 5-83)).
Clear – Please leave the portal.	If the measured contamination is below alarm levels, the user is advised to leave the portal (see CLEAR result (page 5-88)).

Measurement abandoned.	If the user exits the portal on the ingress side before the measurement is complete (see Violations during Monitoring (page 5-83)).
Instrument Out of Service.	If the portal is entered when the unit is out of service, the user is advised to leave the portal (see Out Of Service (page 5-97)).
Measurement Incomplete. Please re-enter the portal and start again.	If the user exits the portal on the egress side before the measurement is complete (see Violations during Monitoring (page 5-83)).
Please leave and re-enter the portal to start measurement.	If the user does not fully exit the portal on completion of measurement (see Violations during Monitoring (page 5-83)).

Note: The speaker volume is user adjustable in System|Setup (page 5-62).

Network Communications

An RJ45 connector provides for compliance with ***IEEE 802.11*** and is located in the roof access. All instruments present this connector at the main cable entry on the roof of the assembly.

USB Ports

A four port USB (version 1.1) hub is available, and these ports are presented below the LCD display for peripheral interfaces (such as memory sticks, security dongle, keyboard, mouse, etc.)

Services Required

Power Requirements

Voltage	-	85 to 264 volts AC
Frequency	-	47 to 63 Hz
Maximum power	-	65 V.A. *
Circuit Protection	-	Integral mains fuse in Power supply 250V 2A
Mains Isolation	-	An Isolator/thermal trip 230V 5A capacity

Battery Backup †

Battery type	Sealed lead-acid
Battery capacity	12 volts 17Ah
Battery support	typically up to 8 hours
Battery Fuse	4Amp PTC self-resetting

Gas Requirement

Gas Type: Argon/Methane

Mixture: P10 (10% Methane/ 90% Argon)

P7.5 (7.5% Methane/ 92.5% Argon) Non flammable – recommended

P5 (5% Methane/ 95% Argon). Non flammable

(10% Carbon Dioxide/90% Argon). Non flammable

Flow: Minimum 25cc/min (Beta only operation)

Normally 50cc/min (Recommended for Peak alpha performance)

Purge: 500cc/min

Pressure: 14 to 34.5 kP, or

2 to 5 psi, or

0.15 to 0.35 Bar.

Consumption:

Gas Bottle Life (days)	Small Bottle 1.27 m^3	Large Bottle 6.38m^3
25cc/min (1.5 L/hr)	30 days	175 days
50cc/min (3.0 L/hr)	15 days	87 days

Bottle Life includes initial System purging.

Servicing Access

Front/Rear: No access is required from front or back of the cabinet – so the iPCM12 can be installed against a wall or another iPCM12

Sides: Clearance of 400 mm is required on right hand side for access to main electronics assemblies. Vlearance of 300 mm is required on right hand site to allow opening of the hinged array frame.

Top: Clearance of at least 200 mm is required to access the electronics and door closer adjusters.

Dimensions (approximate)

Overall Dimensions (excluding LCD but including foot-plate)

	iPCM12A (open)	iPCM12B (Closed)	iPCM12C (closed gamma)
Height	87. 5”/ 2220 mm	87.5”/ 2220 mm	88.5”/ 2240 mm
Width	37”/ 940 mm	37”/ 940 mm	37”/ 940 mm
Depth	29”/ 735 mm	46.5"/ 1330 mm	46.5”/ 1330 mm

Monitoring Area

Height: 2020 mm (max.)

Width of Array: 520 mm

Total Monitoring Area: 15300 cm^2 (basic unit)
16700 cm^2 (with optional detectors)

Weight

iPCM12A – standard open unuit	approx. 300 kg (660 lb)
iPCM12B – standard closed unit, no doors	approx. 500 kg (1100 lb)
iPCM12B – with 2 doors	
iPCM12C – includes gamma option and ful lead shielding	approx. 1700 kg (3750 lb)

Shielding (for Gamma Monitoring Version) - Option

Booth front and back shield consist of 20 mm of lead.

Environmental

Temperature and Humidity

Operational Temperature Range	+0°C to +45°C (32°F to 113°F
Storage Temperature Range	-10°C to +50°C(14°F to 122°F
Humidity Range	up to 95% RH non condensing

NOTE:
USE BELOW +0°C (32°F) IS NOT RECOMMENDED – THE LCD DISPLAY WILL BECOME "SLUGGISH" BELOW THIS TEMPERATURE.
DO NOT STORE ABOVE +60°C (122°F)

Magnetic Shielding

There is no magnetic shielding.

Large external magnetic fields may reduce the measured value.

IP rating

IP50

Environmental restrictions

- Not for use in flammable or explosive atmospheres
- For installation in "drip-free" locations only
- Do not expose to excessive dust pollution levels

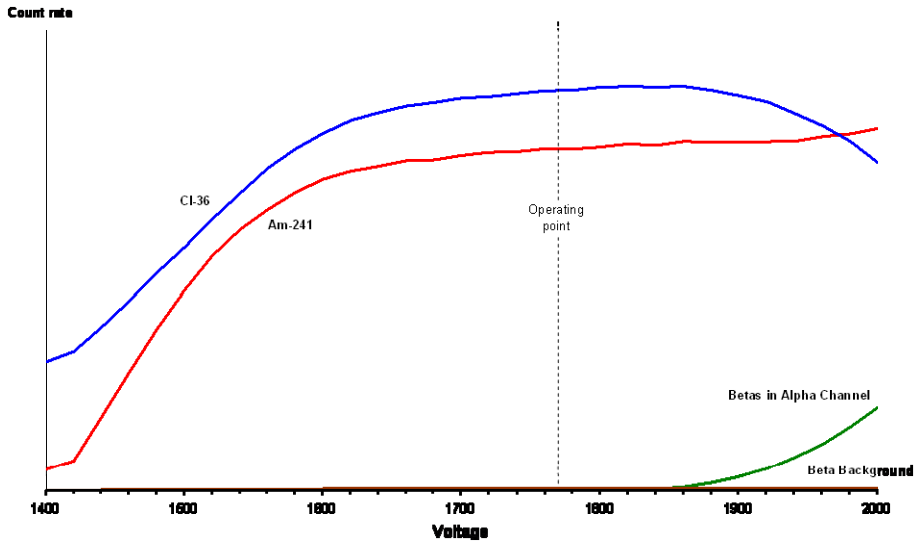


Figure 1 Typical Detector Performance Graph

Chapter 4 Unpacking and Installation

This section will be available in a future issue.

Chapter 5 Operating Instructions

Operational States

There are two operational states for the **iPCM12**:

ADMINISTRATOR Mode – this mode allows the instrument to be configured, calibrated and diagnostic checks to be run. Access to this state requires a username and password. See Administrator Mode (page 5-1) for further details.

USER Mode – this mode supports the normal monitoring of personnel. Any user can operate the instrument in this state. See User Mode (page 5-66) for further details.

Administrator Mode

Note that communications with the iPCM12 is via a touchscreen and this manual has been written primarily giving instructions for the touchscreen commands. It is also possible to use a USB keyboard and mouse to communicate with the iPCM12.

Using the Touchscreen Functions

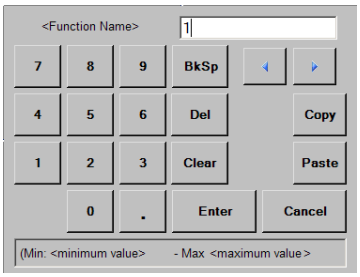
This section describes the methods that are common to all the entry and data viewing operations in the Parameter Mode menus.

When using the touchscreen, directly touch the menu options on the screen when selecting a function.

CAUTION: IT IS ADVISED TO USE A CLEAN FINGER TO TOUCH THE SCREEN. DO NOT USE SHARP OBJECTS ON THE TOUCHSCREEN SUCH AS PENCILS, PENS, SCREWDRIVERS ETC.

Number Functions

When touching the screen in a numerical field, the following number pad appears:



Note that the Function Name, minimum and maximum values are displayed depending on the function selected.

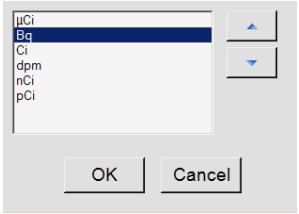
If an illegal value is entered, the value is highlighted in red:

Alpha-numerical Functions

When touching the screen in an alpha-numerical field, the following keyboard appears:

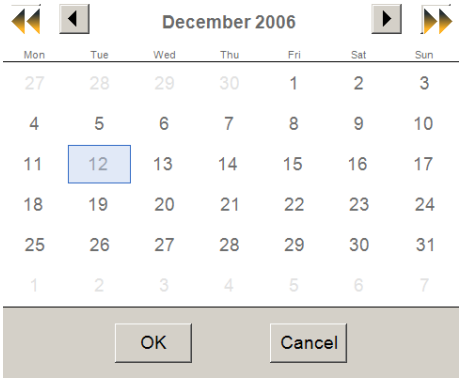
Pre-defined Functions

When touching the screen in a pre-defined field, the following window appears:



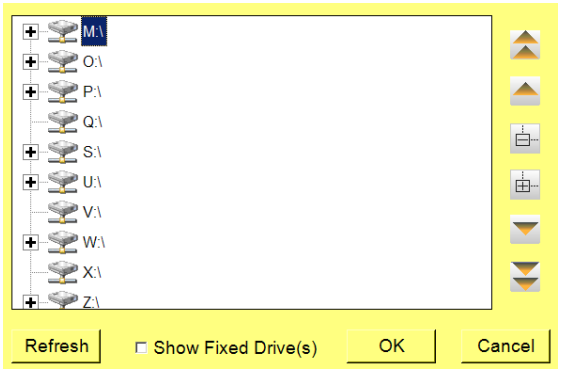
Date Functions

When touching the screen in a date field, the following date selection window appears:



File Location Functions

When touching the screen in a File Location field, the following Drive selection window appears:



Button Types

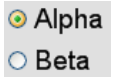
The Button types are listed below:

Direction Arrows steps through the menu options

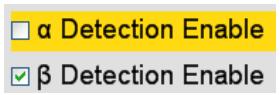
Drop-down lists allows you to select a pre-defined option from the list.

Action button show the process taken when selected.

Tick Boxes show independent options that you can choose to set, or mark. The choice can be toggled on and off by touching on the box.



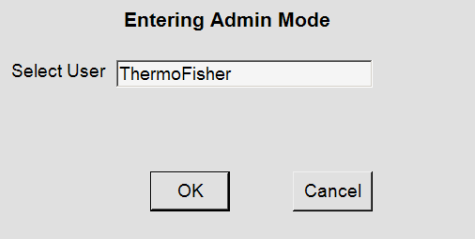
Radio Buttons show mutually exclusive options; choosing one option automatically clears the others. The black dot shows the selected option.



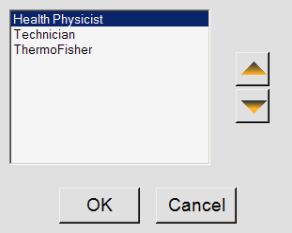
Note that changes made to fields are highlighted until applied or cancelled.

Gaining Access to the Administration Mode

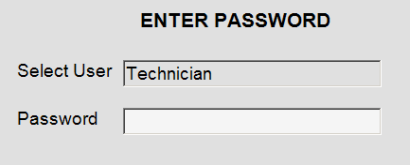
Administration mode is entered by pressing on 'iPCM12' in the bottom left-hand corner of the touchscreen when the iPCM12 is in Background Checking mode. The Entering Admin Mode window is displayed requesting to select a User:



To select a different user to the one displayed, press the User field of the touchscreen. Select Health Physicist, Technician or ThermoFisher using the Up/Down arrow and select OK. See Foreword (page xv) for more information regarding the roles.

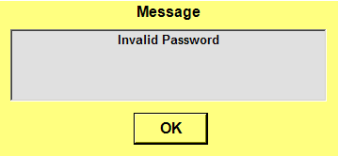


In the Entering Admin Mode window, select OK for the ENTER PASSWORD window (see below) and the Alpha-numeric keyboard to be displayed:



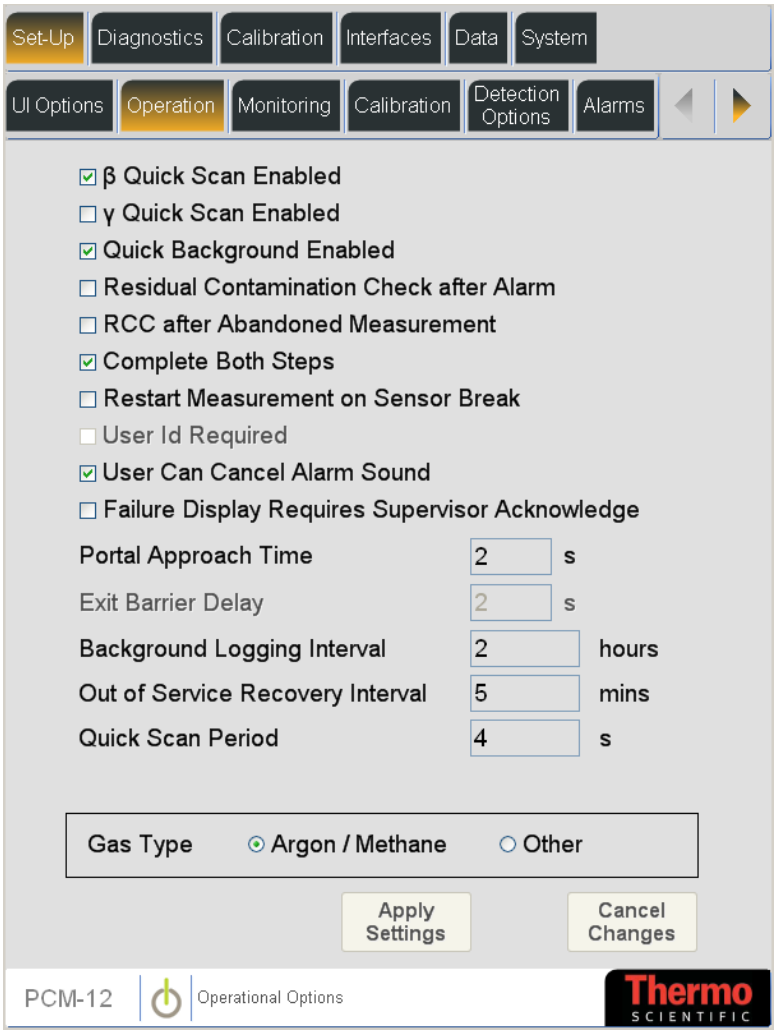
Enter the password using the keyboard and select OK to enter the Administration Mode – note that the Diagnostics – Detector window is initially displayed (see Passwords (page 5-64) for details). The various options available in the Administration Mode are displayed in Menu Roles (page 5-6).

Entering an invalid password will display the following message:



Press OK to re-display the Enter Admin Mode screen.

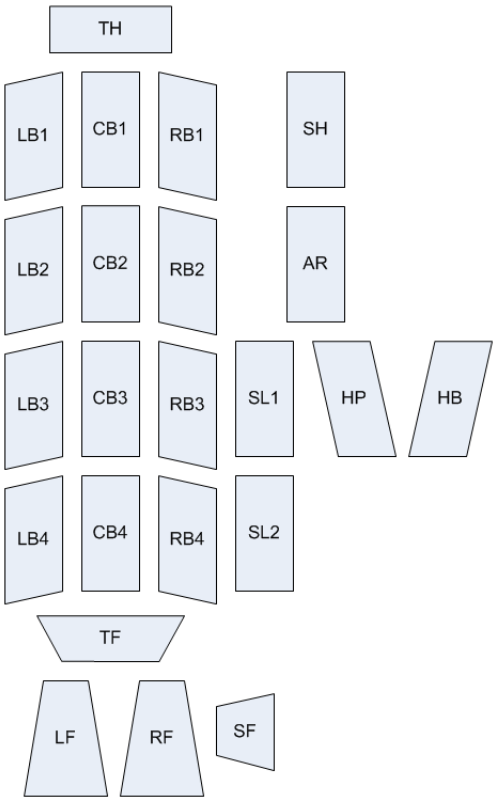
Moving through the Menus



To move through the menus, select the Main menu option on the top line to display the sub-menus available. Then select the sub-option from the second line. Note that a full list of menu and sub-menu options is displayed in Menu Roles below.

Selecting Detectors

On some screens, an option is available to select Detectors. To select individual Detectors, press the corresponding number in the graphic:



TH	Top of Head
LB1	Left Body (Top)
CB1	Centre Body (Top)
RB1	Right Body (Top)
SH	Side of Head / Shoulder
LB2	Left Body (Upper Middle)
CB2	Centre Body (Upper Middle)
RB2	Right Body (Upper Middle)
AR	Upper Arm
LB3	Left Body (Lower Middle)
CB3	Centre Body (Lower Middle)
RB3	Right Body (Lower Middle)
SL1	Side of Leg Upper
LB2	Left Body (Bottom)
CB4	Centre Body (Bottom)
RB4	Right Body (Bottom)
SL4	Side of Leg Lower
HP	Hand Palm
HB	Hand Back
TF	Top of Foot
LF	Left Foot Sole
RF	Right Foot Sole
SF	Side of Foot

For further information regarding Detectors, see Scintillation Detectors Type 5708A & 5717A (page 2-5).

Menu Roles

The following options are available depending on the role selected:

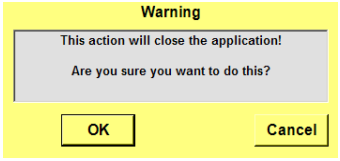
			Role Name		
Main Menu	**Sub-menu**	**See Page**	**Health Physicist**	**Technician**	**Thermo Fisher**
Set-Up	UI Options	5-8	√		√
	Operation	5-10	√		√
	Monitoring	5-12	√		√
	Calibration	5-15	√		√
	Detection Options	5-16	√		√
	Alarms	5-18	√		√

			Role Name		
Main Menu	Sub-menu	See Page	Health Physicist	Technician	Thermo Fisher
	XChannel	5-19	√		√
	Battery	5-20	√		√
	Gas Flow	5-21	√		√
	Barriers	5-22	√		√
	Messages	5-24	√		√
Diagnostics	Detectors	5-24	√	√	√
	Timed Counts	5-25	√		√
	Information	5-26	√	√	√
	Alarm Check	5-27	√	√	√
	Position Sensors	5-28	√	√	√
	Lamps	5-29	√	√	√
	HV Gen	5-30	√	√	√
	Battery Charger	5-31	√	√	√
	Barriers	5-31	√	√	√
	Gas Flow	5-32	√	√	√
Calibration	Efficiencies	5-33	√	√	√
	Cal Status	5-33	√		√
	Cal Check	5-34	√	√	√
	Cal Streams	5-40	√	√	√
	HV Scan	5-41	√		√
	Thresholds	5-47			√
	Sources and Jigs	5-48	√		√
Interfaces	Plug-ins	5-48	√		√
Data	Reports	5-50	√		√
	Archives	5-61	√		√
System	Actions	5-62	√	√	√
	Setup	5-62	√	√	√
	Version	5-64	√	√	√
	Passwords	5-64	√		√
	Data Retention	5-65	√		√

Exiting the Administration Mode

To exit Administration mode, press on 'PCM-12' in the bottom left-hand corner of the touchscreen. Login to the Administration mode – see Gaining Access to the Administration Mode (page 5-4).

Select the System main menu option and then the Actions sub-menu option. Select the Exit Application button. A warning message is displayed asking for confirmation:



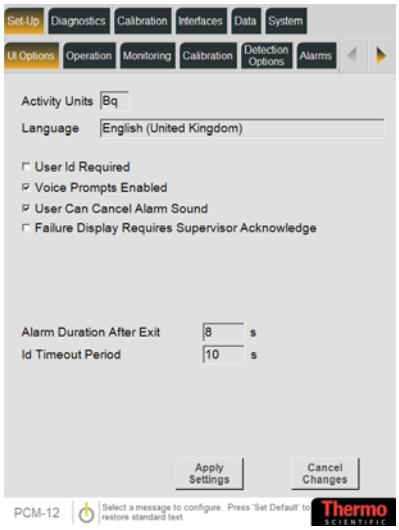
Select OK to exit and Cancel to abandon the exit process. For further information, see Actions (page 5-62).

Upon exiting from the Keypad Parameter Mode, a Cold Start mode will be run if a change to the configuration has been made – see Cold Start State (page 5-69).

Setup Menu

UI Options

Select Set-Up|UI Options to customise the iPCM12's operation:

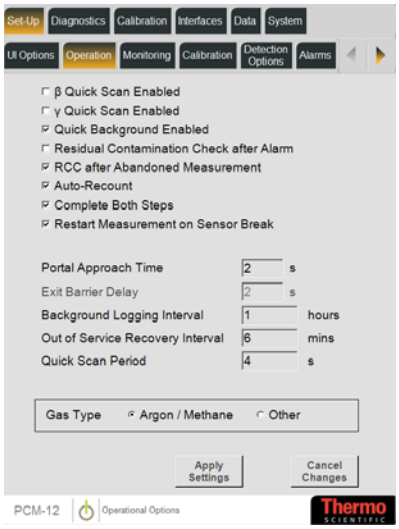


Description of options:

Field Name	Description
Activity Units	Use the pre-defined window to select a unit from one of the following: • dpm • Bq • kBq • pCi • nCi • µCi • mCi • Ci This changes the displayed activity units for the iPCM12. Default: dpm
Language	Use the pre-defined window to select a language. This changes the displayed language for the iPCM12.
User Id Required	This option ensures that the user must enter his ID using the barcode reader before the portal will operate. The following message is displayed: Enter Id and then Enter See User ID (page 5-79) for information on how this is implemented in the Monitoring process. Default: OFF
Voice Prompts Enabled	Tick this option to enable voice prompts to be audible. For more information regarding the prompts and where they are used, see Audible Indications (page 3-8). Default: OFF
User Can Cancel Alarm Sound	This option allows the user to press the Alarm Acknowledge button when an alarm has taken place. See Cancel Alarm (page 5-93) for more information on clearing the alarms. Default: OFF

Failure Display requires Supervisor Acknowledge	This option ensures that a supervisor has to insert a dongle and press the Alarm Acknowledge button when a failure (or alarm) has taken place. Note that the alarm will continue to display and sound until the supervisor acknowledges it. See Cancel Alarm (page 5-93) for more information on clearing the alarms. Default: OFF
Alarm Duration after Exit	This is the length of time that the alarm displays/sounds after the user has exited the portal. See Cancel Alarm (page 5-93) for more information on clearing the alarms. Values: 0 to 300 s Default: 2 seconds
Id Timeout Period (s)	This is the maximum length of time allowed between entering the User ID and entering the portal. It is also used as the maximum length of time (in seconds) allowed for the user to present their ID after entered the portal. *Note that User Id Required (see above) has to be ticked for this option to be effective.* Values: 0 to 300 s Default: 10 seconds

Operation Select Set-Up|Operations to customise the iPCM12's operation:



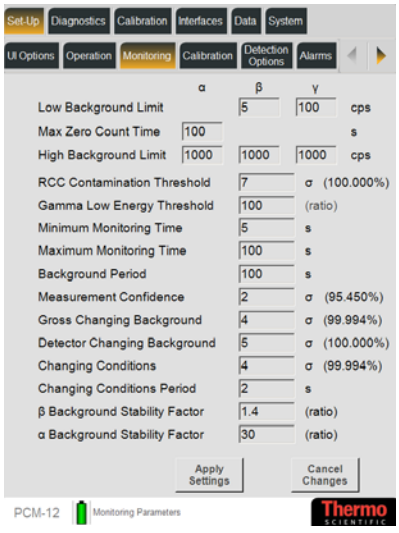
Description of options:

Field Name	Description
β Quick Scan Enabled γ Quick Scan Enabled	These options may be enabled to allow "real-dirty" or "real-clean" to be identified before end of monitoring period. Also, see Quick Scan Period below. Default: OFF
Quick Background Enabled	Tick this option to reduce the time taken to establish a background, i.e. background is considered valid as soon as alarm requirements are met. If this option is not ticked, the time taken to establish a background is 100 seconds. Default: OFF
Residual Contamination Check after Alarm	Tick this option to enable a Residual Contamination Check to be automatically performed following an Alarm. For further information regarding Residual Contamination Checks, see Residual Contamination Check (page 5-93).
RCC after Abandoned Measurement	Tick this option to enable a Residual Contamination Check to be automatically performed following an abandoned measurement (see Violations during Monitoring (page 5-83)). For further information regarding Residual Contamination Checks, see Residual Contamination Check (page 5-93).
Auto-Recount	Tick this option to enable an automatic recount to take place if the measurement is recorded as an alarm.
Complete Both Steps	During a measurement, the first step is the user facing the detector array and the second step is where the user rotates 180 degrees to face away from the detector array. Tick this option for the user to perform the second step of the measurement.
Restart Measurement on Sensor Break	Tick this option to re-start a measurement if the user moves and breaks the sensor (see Position Sensors (page 5-28)).
Portal Approach Time (s)	This is the maximum length of time following entry to the portal that the user has to move to the correct position in the portal. Values: 0 to 300 s Default: 2 seconds
Exit Barrier Delay (s)	This is the maximum length of time that the user has to re-position themselves in the portal following exit or illegal movement during measurement. Values: 0 to 300 s Default: 2 seconds

Background Logging Interval (hours)	Select an interval between 1 and 168 hours for the iPCM12 to periodically log the background. Select 0 to disable the periodic logging. *Note that each time a mandatory 100 second background is performed the backgrounds for each detector will be logged to the database.* Values: 1 to 168 hours (0 to disable) Default: 0
Out of Service Recovery Interval (mins)	When the unit is Out of Service (see Out Of Service (page 5-97), the system automatically clears the error after the Out of Service Recovery Interval has passed. Select 0 to disable the Recovery Interval. Values: 0 to 60 mins Default: 0
Quick Scan Period (s)	This option may be enabled to allow "real-dirty" or "real-clean" to be identified before end of monitoring period. Also, see Quick Scan Period in Calibration (page 5-15). Quick Scan is disabled during automatic and manual recounts. This is the length of time (in seconds) for the Quick Scan to run (see UI Options (page 5-8)). Values: 3 to 60 s Default: 10 s
Gas Type	Select a Gas Type from one of the following radio buttons: • Argon / Methane • Other

Monitoring

Select Set-Up|Monitoring to customise the first set of Operational Parameters:



Description of options:

Field Name	Description
Low Background Limit β γ (cps)	If a background measurement falls below this value (counts per second), a detector failure will occur. Values: 0 to 99,999 cps (0 to disable) Default: 50cps
Max Zero Count Time α (s)	If no counts are received within the Max Zero Count Time, the instrument will go "Out of Service" with a Low Alpha Background. Values: 0 to 99,999 cps (0 to disable) Default: 50cps
High Background Limit α β γ (cps)	If a background measurement goes above this value (counts per second), a detector failure will occur. Values: 0 to 99,999 cps (0 to disable) Default: 10000cps
RCC Contamination Threshold (σ)	This is the statistical increase during a Residual Contamination Check compared to the background measurement. *Note that the RCC Contamination Threshold is also expressed as a percentage in parentheses.* Values: 0.1 to 7 sigma in 0.1 sigma steps Default: 7 σ
Gamma Low Energy Threshold (ratio)	This facility utilizes information on the ratio between count rates above thresholds to decide whether the radioactivity present is emitting photon radiation of low energy (i.e. <400 keV). Any ratio of T1/T2 which exceeds this threshold will be deemed low energy. See NBR Method (page 9-8) for further information. Values: 50 to 10,000 Default: 100
Minimum Monitoring Time (s)	*Note that the Minimum monitoring time must be equal to or less than Maximum Monitoring Time.* This is the Minimum time for which contamination is monitored. This field is used in conjunction with the Maximum Monitoring Time. Values: 3 to 300 s Default: 5 s

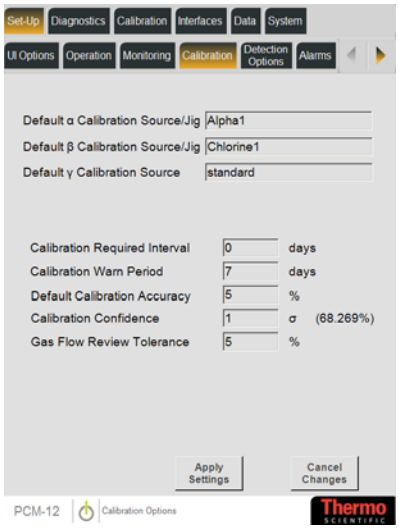
Maximum Monitoring Time (s)	*Note that the Maximum monitoring time must be equal to or greater than Minimum monitoring time. It must be set to a high enough value to prevent a high background fault.* This is the Maximum time for which contamination is monitored. A monitoring time is calculated by the iPCM12 to meet the background and the statistical requirements. For given alarm and statistical requirements this parameter will limit the background count-rate allowed. To achieve a fixed monitoring time, set the minimum and maximum monitoring times to the same value. Values: 3 to 300 s Default: 100 s
Background Period (s)	This is the current background period. The value is set at 0 if a background has not yet been acquired.
Measurement Confidence (σ)	The instrument uses this figure to calculate the effective alarm level. It is the number of standard deviations measured against the Alarms (see Alarms (page 5-18)). *Note that the Measurement Confidence is also expressed as a percentage in parentheses.* Values: 0.1 to 10 sigma in 0.1 sigma steps. Default: 2 σ
Gross Changing Background (σ)	This statistical variable is used by iPCM12 to determine if a changing background condition exists on all detectors. *Note that the Gross Changing Background is also expressed as a percentage in parentheses.* Values: 0.1 to 7 sigma in 0.1 sigma steps Default: 5 σ
Detector Changing Background (σ)	This statistical variable is used by iPCM12 to determine if a changing background condition exists on a single detector. *Note that the Detector Changing Background is also expressed as a percentage in parentheses.* Values: 0.1 to 7 sigma in 0.1 sigma steps Default: 7 σ
Changing Conditions (σ)	This statistical variable is used by iPCM12 to determine if a changing measurement condition exists. *Note that the Changing Conditions are also expressed as a percentage in parentheses.* Values: 0.1 to 7 sigma in 0.1 sigma steps Default: 7 σ

Changing Conditions Period (s)	This is the length of time used by iPCM12 to determine if a changing measurement condition exists. Values: 2 to 30 s Default: 3 s
β Background Stability Factor (ratio)	The stabilization routine is triggered when any single detector has a background count that is outside limits defined by the current average and these Background Stability Factors.
α Background Stability Factor (ratio)	

For further information regarding these options, contact Thermo Fisher Scientific.

Calibration

Select Set-Up|Calibration to customise the Calibration Parameters:



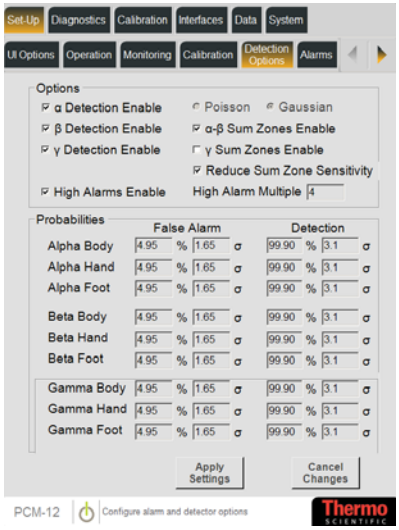
Description of options:

Field Name	Description
Default α Calibration Source/Jig	Use the pre-defined window to select a Calibration Source/Jig. These Sources/Jigs are setup in the Calibration|Sources and Jigs (page 5-48).
Default β Calibration Source/Jig	
Default γCalibration Source	
Calibration Required Interval (days)	This is the number of days since that last calibration date before the unit needs to be calibrated again. See Out of Calibration (page 5-72) to view the message displayed on the unit when out of date and Cal Check (page 5-34) for information of the last Calibration Date. Values: 1 to 400 days (0 to disable) Default: 0

Calibration Warn Period (days)	This is the number of warning days that will be given to the user that the unit needs to be calibrated again. See Out of Calibration (page 5-72) to view the message displayed on the unit when out of date and Cal Check (page 5-34) for information of the last Calibration Date. Values: 1 to 400 days (0 to disable) Default: 0
Default Calibration Accuracy (%)	*Note that this is a view only field.* This is the default Calibration Accuracy used in the Calibration Check utility - see Cal Check (page 5-34). It is used, along with the background measurement, determines the count time required with the iPCM12 is being calibrated. Values: 0.5 to 10% in 0.1% steps Default: 1.00 %
Calibration Confidence (σ)	*Note that this is a view only field.* This factor affects the monitoring time of calibration. Values: 0.1 to 4 sigma in 0.1 sigma steps Default: 2
Deviation from Previous (%)	If the percentage difference for the α and β detectors between the current and previous calibration is more than this value, the calibration is to be reviewed. Values: 5 to 100% Default: 5

Detection Options

Select Set-Up|Detection Options to customise the Alarm and Detection compare Options:

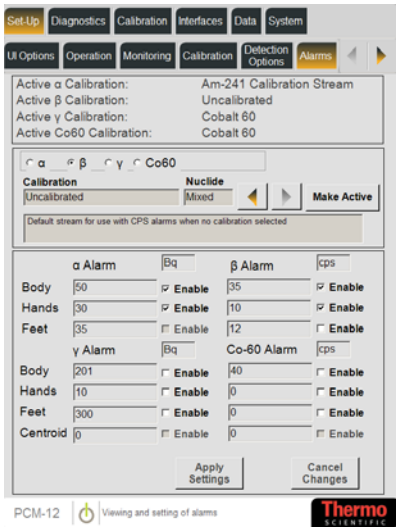


Description of options:

Field Name	Description
α Detection Enable	Tick this option to enable α detection.
Poisson / Gaussian	Tick Poisson for discrete probability distribution and Gaussian for normal distribution of results. Note that this section is set by at production and should only be changed in consultation with Thermo Fisher Scientific.
β Detection Enable	Tick this option to enable β detection.
α-β Sum Zones Enable	Tick this option to enable two zones being added together. See Zone Summation (if required) (page 6-16) for further information.
γ Detection Enable	Tick this option to enable γ detection.
γ Sum Zones Enable	Tick this option to enable the γ zones to be summed together.
Reduce Sum Zone Sensitivity	Tick this option to decrease the sensitivity when Sum Zones has been ticked.
High Alarms Enable	Tick this option to enable High Level alarms. Default: OFF
High Alarm Multiple	Enter a multiple against the normal alarms levels at which the high alarm levels will detect. Values: 1 to 1000 Default: 5
Probability of False Alarm (% and σ) for: Alpha Body Alpha Hand Alpha Foot Beta Body Beta Hand Beta Foot Gamma Body Gamma Hand Gamma Foot	This value is the probability that a false alarm will NOT be given during a measurement. This probability is used by iPCM12 to determine the monitoring time and the Effective Alarm Level and Minimum Detectable Activity. For further information, see Description of Parameters Used in Calculations (page 6-9). *Note that the Probability of False Alarm is also expressed as a percentage in parentheses.* Values: 0 to 10 sigma in 0.1 sigma steps. Default: 3.1 σ
Probability of Detection (% and σ) for: Alpha Body Alpha Hand Alpha Foot Beta Body Beta Hand Beta Foot Gamma Body Gamma Hand Gamma Foot	This is the probability that exactly one alarm Level of contamination will cause and alarm. For further information, see Description of Parameters Used in Calculations. *Note that the Probability of Detection is also expressed as a percentage in parentheses.* Values: 0 to 10 sigma in 0.1 sigma steps. Default: 1.65 σ

Alarms

Select Set-Up|Alarms to select the Active Calibration Stream and set the alarms:



Description of options:

Field Name	Description
α β γ Co60	These values are displayed if they are selected in the Detection Options (page 5-16). Select a Radiation Type in order to activate a Calibration.
Calibration / Nuclide	Use the direction arrows to change the Calibration type. When the type is correct, select the Activate button. *Note that a description of the Calibration Type is displayed in the field below.*
α Alarm for: · Body · Hands · Feet	This is the detected activity at which iPCM12 will indicate an Alarm. Tick the Enable box to enable the alarm. Values: 0 to 10,000,000 (Any unit).
β Alarm for: · Body · Hands · Feet	This is the detected activity at which iPCM12 will indicate an Alarm. Tick the Enable box to enable the alarm. Values: 0 to 10,000,000 (Any unit).
γ Alarm for: · Body · Hands · Feet · Centroid	This is the detected activity at which iPCM12 will indicate an Alarm. Tick the Enable box to enable the alarm. Values: 0 to 10,000,000 (Any unit).
Co60 Alarm for: · Body · Hands · Feet · Centroid	This is the detected activity at which iPCM12 will indicate an Alarm. Tick the Enable box to enable the alarm. Values: 0 to 10,000,000 (Any unit).

To create a new Alarm:

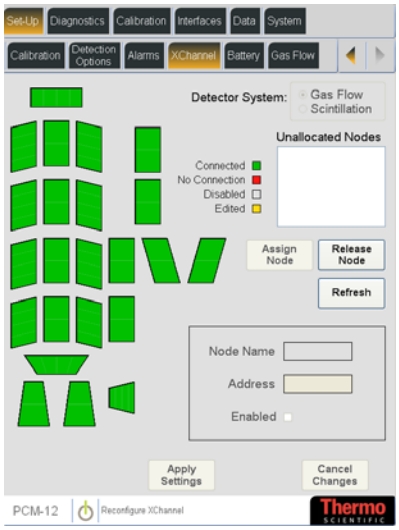
1. Select α, β, γ or Co60
2. Select a Calibration type using the Left and Right Arrows
3. Select an Alarm rate from the drop-down box (e.g. Activity Units or cps)
4. Enter the Alarm levels for Body, Hands, Feet and Centroid (if displayed)
5. To use this alarm for Calibration, select the Active button.

XChannel

Select Set-Up|XChannel to configure the XChannel:

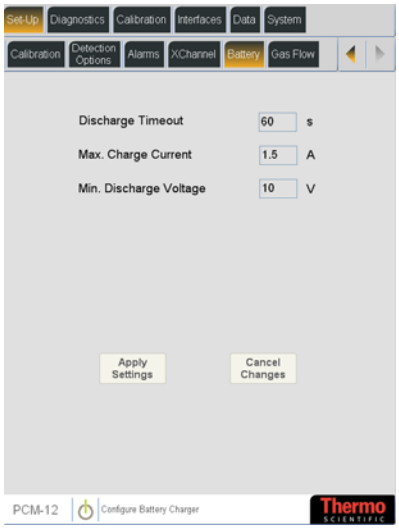
Note that the following message is displayed while node data is being collected:

As each node is selected, its data is displayed:



Note that this section is set by at production and should only be changed in consultation with Thermo Fisher Scientific.

Battery Select Set-Up|Battery to configure the Battery Charger



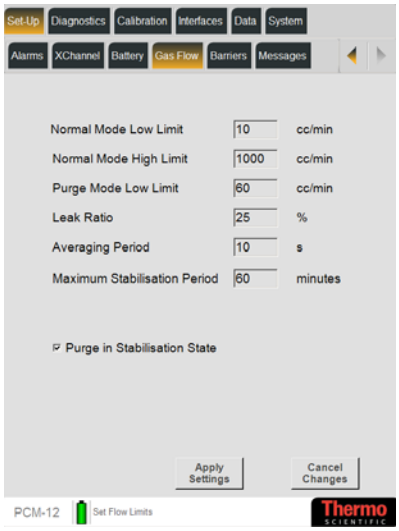
Note that this section is set by at production and should only be changed in consultation with Thermo Fisher Scientific.

Description of options:

Field Name	Description
Discharge Timeout (Secs)	This is the amount of time after the battery discharges to the minimum discharge voltage before the charger turns off the output power. If the charger is already running on battery power, the value of the timeout will not e changed The timer can only be stopped if the mains power is returned
Max. Charge Current (A)	This is the maximum current allowed for charging the battery. The charge current is monitored constantly and the PSU output voltage is reduced if this current is exceeded.
Min. Discharge Volume (V)	This is the voltage at which the timer starts, when the battery is being discharged.

Gas Flow

Select Set-Up|Gas Flow to configure the Gas Flow:



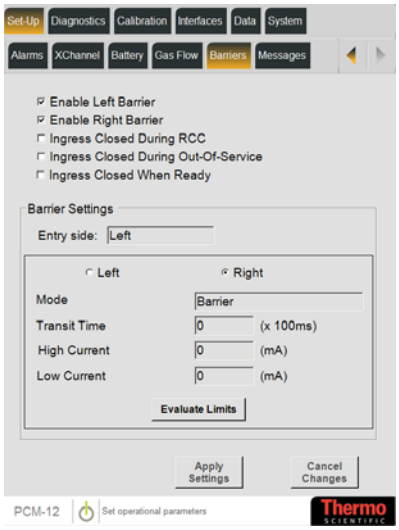
Note that this section is set by at production and should only be changed in consultation with Thermo Fisher Scientific.

Description of options:

Field Name	Description
Normal Mode Low Limit (cc/min)	If the Gas Flow falls below this limit, the iPCM becomes out of service (see Out Of Service (page 5-97)). Values: 0 to 1000
Normal Mode High Limit (cc/min)	If the Gas Flow goes above this limit, the iPCM becomes out of service (see Out Of Service (page 5-97)). Values: 0 to 1000
Purge Mode Low Limit (cc/min)	If the Gas Flow falls below this limit when in Purge Mode, the iPCM becomes out of service (see Out Of Service (page 5-97)). Values: 0 to 1000
Leak Ratio (%)	Enter the ratio of gas exhaust rate over the gas inlet rate. If this ratio is exceeded the iPCM becomes out of service (see Out Of Service (page 5-97)).
Average Period (s)	Enter the smoothing period used to determine the rate figures. This will eliminate the peak rates that occur during normal operation. Values: 2 to 10
Maximum Stabilisation Period (minutes)	Maximum time that instrument will stay in stabilization mode before the iPCM becomes out of service (see Out Of Service (page 5-97)). Values: 0 to 65000
Purge in Stabilisation State	

Barriers

Select Set-Up|Barriers to customise the Barriers (if enabled):



Description of options:

Field Name	Description
Enable Left Barrier	Tick this option to enable the Left Barrier – see below for Barrier settings.
Enable Right Barrier	Tick this option to enable the Rear Barrier – see below for settings.
Ingress Closed During RCC	*Note that this option is greyed out unless the Enable Front and/or Rear Barrier options are ticked.* Tick this option to prevent entry into the iPCM while the Residual Contamination Count is performed (see Residual Contamination Check (page 5-93)).
Ingress Closed During Out-Of-Service	*Note that this option is greyed out unless the Enable Front and/or Rear Barrier options are ticked.* Tick this option to prevent entry into the iPCM while the unit is Out of Service (see Out Of Service (page 5-97)).
Ingress Closed When Ready	*Note that this option is greyed out unless the Enable Front and/or Rear Barrier options are ticked.* Tick this option to prevent entry into the iPCM while the unit is Ready (see Normal Background Monitoring (page 5-75)).
Note that the Barrier Settings are only displayed when logged in as ThermoFisher (see Menu Roles (page 5-6). The Barrier Settings are displayed if the Enable Left and/or Right Barrier option is ticked.	
Entry Side	Set either Left or Right as the Entry side for the iPCM.

Entry Settings – Left and Right	
Mode	Use the pre-defined window to select the type of Barrier that may be attached to the unit: · PCF Disabled · Doors · Barrier · Unpowered Doors · Turnstile – Normally Locked · Turnstile – Normally Unlocked
Transit time (x 100ms)	This is the time that is allowed for the worker to pass through the barrier. Values: 0 to 65535 seconds
Low Current Limit (mA)	*Note that this field is only enabled when Right Barrier Setting is selected.* This is the Low Current Limit below which the barrier will stall (see Evaluate Limits below for further explanation). Values: 0 to 65535 milliamps
High Current Limit (mA)	*Note that this field is only enabled when Right Barrier Setting is selected.* This is the Low Current Limit above which the barrier will stall (see Evaluate Limits below for further explanation). Values: 0 to 65535 milliamps
Evaluate Limits	*Note that this button is greyed out unless Barrier Mode is selected.* Select this button to commence a test sequence for the Barrier Mode which will check the operation of the Barrier and detects the Low and High Current Limits. IMPORTANT – this button activates the Barrier to open and close. The **actual** values for the Low and High Current Limits are inserted into these fields. However, it is strongly advised that the Current Limit fields are set to the following values: Low Current Limit = between 0 and 10 High Current Limit = 1.5 x **actual** High Current Limit This will prevent the stall detection operating on the Barrier during normal usage.

Messages

It is possible to amend the Headline(s) and Instructions for the following messages:

- Normal Alarm
- High Level Alarm
- Clear

Select Set-Up|Messages to select a message to configure:

Use the direction arrow to find a Message to configure. Once selected, the text can be updated by pressing on the Headline, Headline 2 and Instruction fields. To save the changes, press Apply Settings button.

To set the selected message back to its default setting, press the Set Default button.

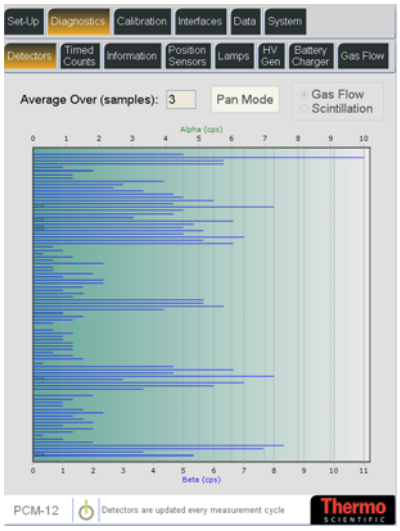
Available Messages:

Message	Headlines and Instructions
Normal Alarm	Contaminated – Please Contact HP
High Level Alarm	High Level – Please Contact HP
Clear	Clear – OK to Leave Portal

Diagnostics Menu

Detectors

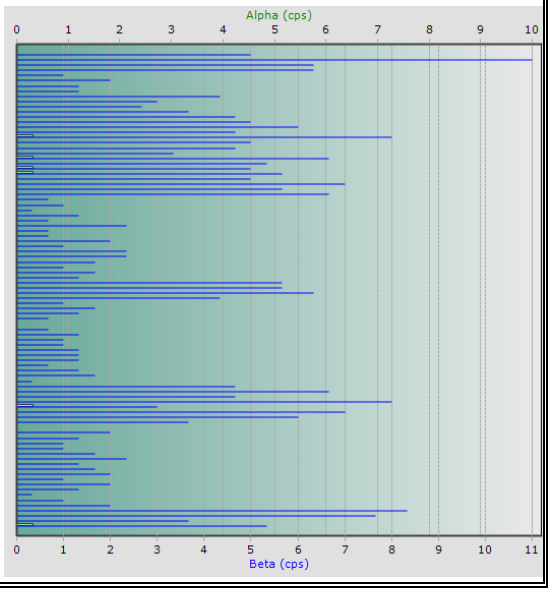
Select Diagnostics|Detectors to view the Detectors information



The Detectors are updated every measurement cycle.

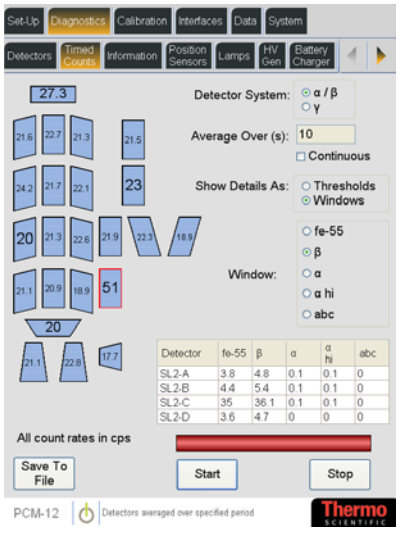
Note that the Background Count Rate is averaged and updated over the cycle time selected in the Average Over field.

Description of options:

Field Name	Description
Average Over (samples)	Enter the number of samples from which the average is calculated for display.
Stacked	Tick to display the graph as a stacked view. If the box is unticked, the view is displayed unstacked as follows: 

Timed Counts

Select Diagnostics|Timed Counts to view Detectors averaged over a selected specified period. This function allows a count to be made which can be used to ascertain the efficiency and functionality of the iPCM12



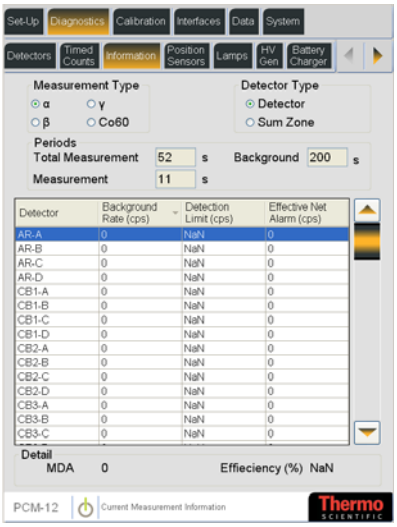
To Start the Timed Counts for the Detectors:

1. Select the Detector System – Alpha/Beta or Gamma.
1. Select the number of counts to be averaged by selecting a value in the Average Over field. If you require a Continuous count to be made, tick the Continuous box.
2. Toggle between the Thresholds and Windows display by clicking on the relevant radio button. Then, further select from the options displayed.
3. Select a Window type from the list displayed.
4. Press Start button.

The counts may be halted at any time by pressing the Stop button. The results can also be saved by pressing the Save to File button and then selecting an directory and file name to save.

Information

Select Diagnostics|Information to view the current Measurement Information



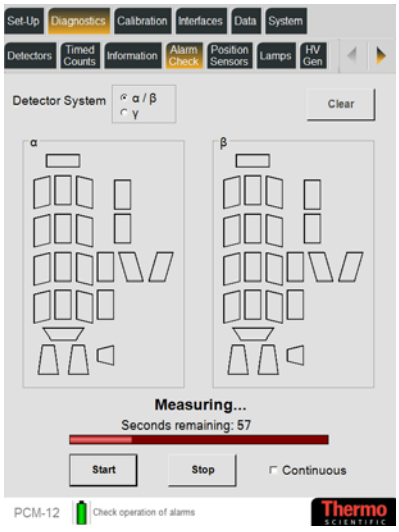
Description of options:

Field Name	Description
Measurement Type	Click on one of the radio buttons to select one of the following: · α– displays the Alpha count for the select Detector Group (see below). · β – displays the Beta count for the select Detector Group (see below). · γ – displays the Gamma count for the select Detector Group (see below). · Co60 – displays the Cobalt 60 count for the select Detector Group (see below).

Detector Type	Click on one of the radio buttons to select one of the following: • Detector – displays the counts for each individual detector • Sum Zone – displays the counts for all detectors
Total Measurement Period (s)	*Note that this is a view only field.* This is the length of time for the sample calculated from the current alarm conditions and background measurement.
Alpha Measurement Period (s)	*Note that this is a view only field.* This is the length of time for the sample calculated from the current alarm conditions and background measurement.
Background Period (s)	*Note that this is a view only field.* This is the current background period. The value is set at 0 if a background has not yet been acquired.
Detector Information	*Note that this is a view only field.* The Background Rate, Detection Limit and Effective Net Alarm are displayed for each Detector. For further information, see Description of Parameters Used in Calculations (page 6-9).
Detail	*Note that this is a view only field.* The Minimum Detection Activity (MDA) and

Alarm Check

Select Diagnostics|Alarm Check to check the operation of alarms.



To test the operation of alarms, select a Detector Type from α / β or γ. At this point, if required, you can insert a source in the monitor. Press the Start Button. The Seconds Remaining will count down until an alarm is detected or until the Quick Scan is triggered (see Operation (page 5-10)) or until the Maximum Monitoring Time has passed (see Monitoring (page 5-12)).

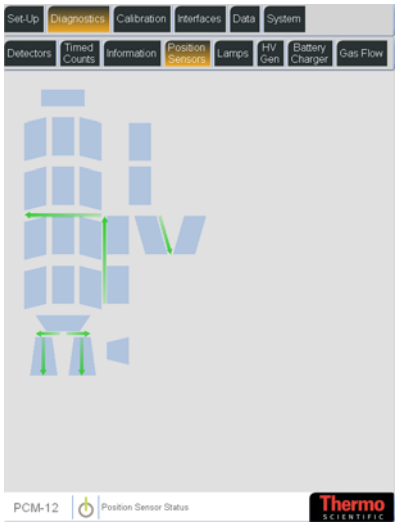
Tick the Continuous box for the Alarm Check to run constantly. Click the Stop button to halt the continuous mode.

Position Sensors

The instrument will have seven sensors for detecting the user's position in the portal as follows:

- Body
- Side of Leg
- Hand
- Left Sole
- Right Sole
- Left Top of Foot
- Right Top of Foot

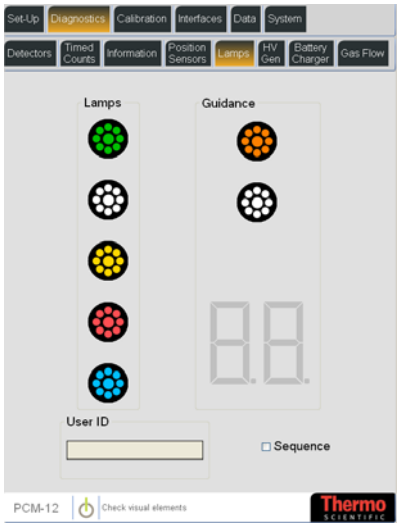
Select Diagnostics|Position Sensors to check the sensors and visual elements.



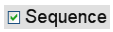
The green arrows in the diagram indicate the Position Sensors on the portal. These will detect when the user is correctly positioned prior to a measurement being taken (see Positioning (page 5-81) for further information.).

Lamps

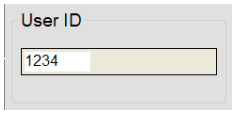
Select Diagnostics|Lamps to check the visual elements.



Select the Sequence tickbox to test the Detector, LED and Lamps display.

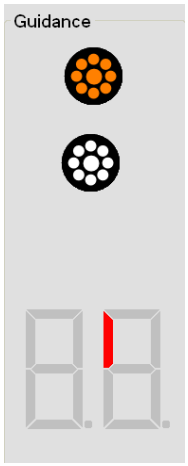


To test User ID, select the User ID input box and enter an ID, as follows:

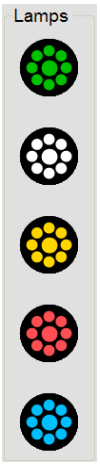


To test the Guidance and LED, tick the Sequence tickbox. Each segment of the LED will turn red sequentially.

Note that the Detectors and Lamps will also light up sequentially.

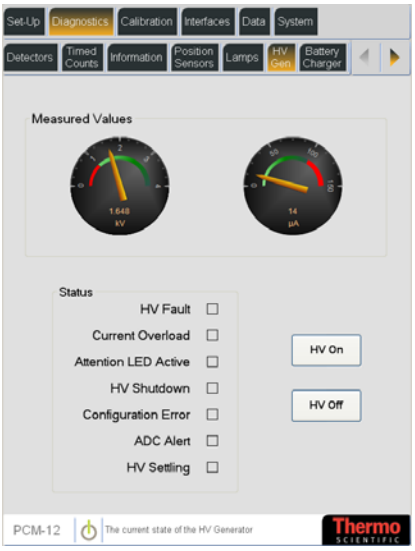


To test the Lamps, press the lamp icon which will light up.



HV Gen

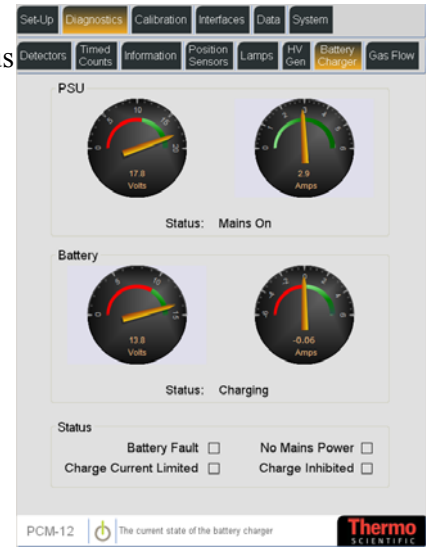
Select Diagnostics|HV Gen to check the current state of the HV Generator:



The Status options give an indication if there is an error with the HV Generator.

Battery Charger

Select Diagnostics|Battery Charger to view the current status of the battery charger:



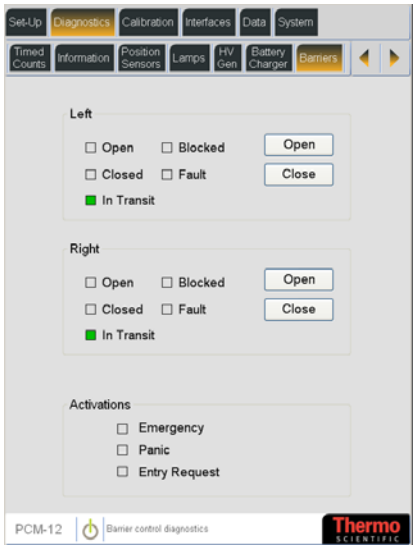
The Status options give an indication if there is an error with the Battery Charger.

When the mains power is ON, the system charges the battery.

When no mains power is present, the system operates from the battery.

Barriers

Select Diagnostics|Barriers to check the installed barriers:



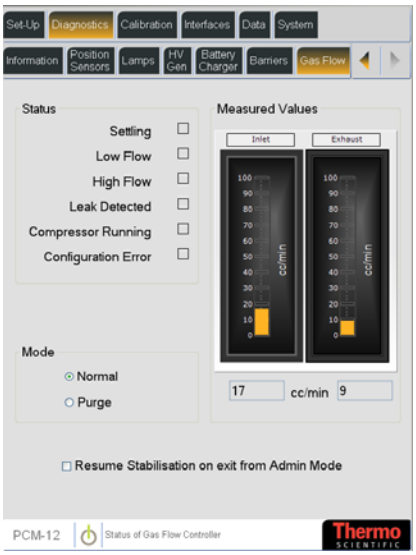
To test the opening/closing of the barriers, tick the Open/Close buttons. The display will indicate with a green box, if the barrier has opened/closed or is in Transit or whether the barrier is Blocked/Faulty, as follows:

To test the Activations, press the Emergency, Panic or Entry Request buttons.

Gas Flow

Note that this is a view only table.

Select Diagnostics|Gas Flow to view the current status of the Gas Flow Controller:

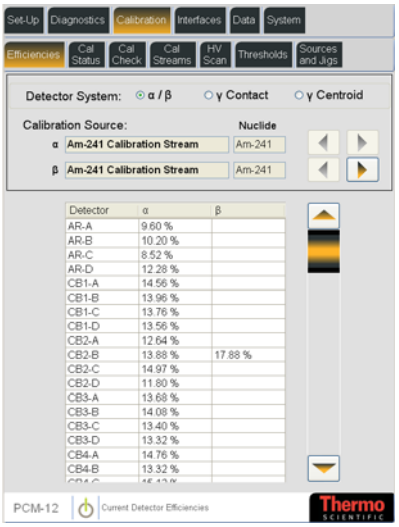


Status	The Status options indicate whether there is an error with the Gas Flow.
Mode	The Mode option indicates whether the Gas Flow is in Normal or Purge Mode.
Resume Stabilisation on exit from Admin Mode	This will be ticked if the Stabilisation was interrupted by access to the Administration Mode.

Calibration Menu

Efficiencies

Select Calibration|Efficiencies to view the Current Detector efficiencies:

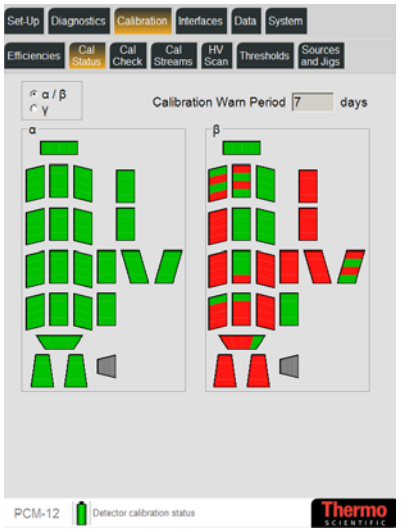


Select a Radiation Type from α / β, γ Contact or γ Centroid.

Once a Radiation Type has been selected, it is possible to select a Calibration Source.

Cal Status

Select Calibration|Cal Status to view the Detector calibration status:



Select a Radiation Type from α / β or γ. The Calibration status of the Detectors is displayed.

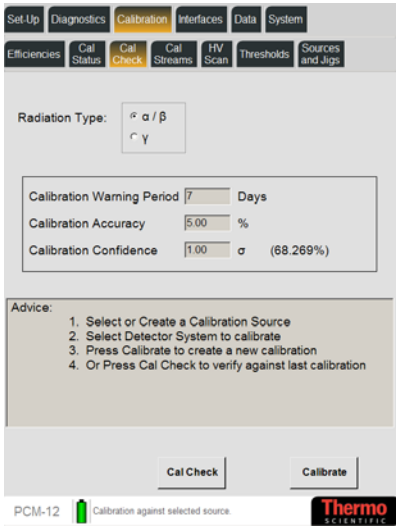
- Disabled
- Out of Calibration
- Calibration Due
- In Calibration

Calibration Warn Period (days)	Set the number of days that the Calibration Warn Period information is displayed to the user. Enter 0 to disable this feature.

Cal Check

This option allows the user to edit existing Calibration sources and create new ones. There are also functions available to allow the user to check or overwrite the current calibration factor.

Select Calibration|Cal Check to edit the Calibration setting against a selected source and to conduct a calibration check.



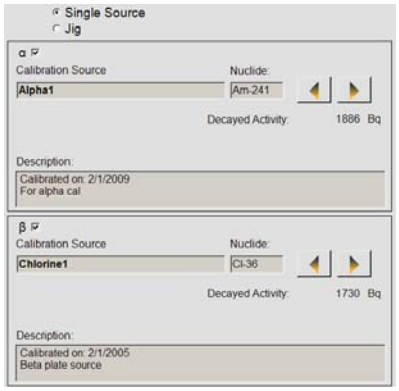
Note that the Calibrate button is not available to the Technician role.

Description of options:

Field Name	Description
Calibration Warning Period (days)	*Note that this is a view only field.* This is the number of days since that last calibration date. See Out of Calibration (page 5-72) to view the message displayed on the unit when out of date.
Calibration Accuracy (%)	*Note that this is a view only field.* This is a copy of the Default Calibration Accuracy field in Calibration (page 5-15).
Calibration Confidence (σ)	*Note that this is a view only field.* This is a copy of the Calibration Confidence field in Calibration (page 5-15).

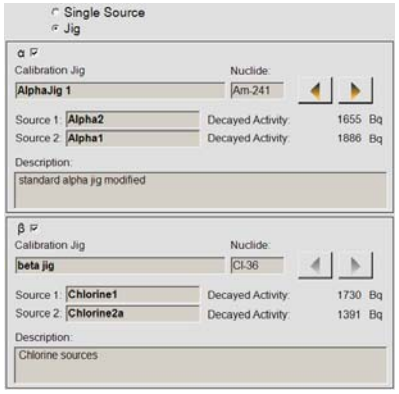
All calibration results are logged to the database. The "Calibrate" function allows users to overwrite the Calibration factor. The "Cal Check" function informs the user of any discrepancy with the current calibration factor.

To Calibrate or Cal Check against α / β, select a Radiation Type = α / β and then press the Calibrate or Cal Check button. The following Calibration Single Source window is displayed.

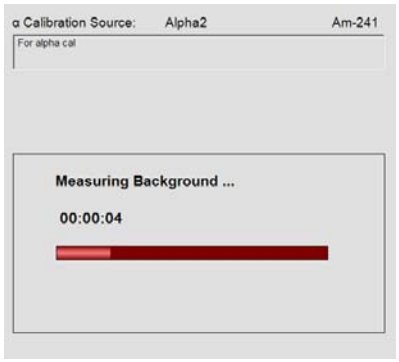


See Sources and Jigs (page 5-48) for more information regarding the setting up of Sources and Jigs.

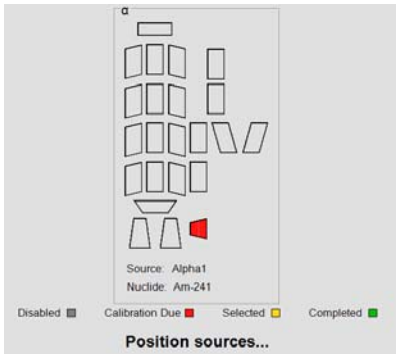
Select the Jig radio button to display the multiple Sources as follows:

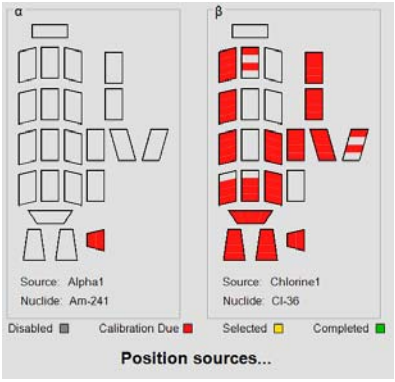


Use the direction arrows to select a Calibration Source. Once selected, press Next button to start the Measurement of the Background:

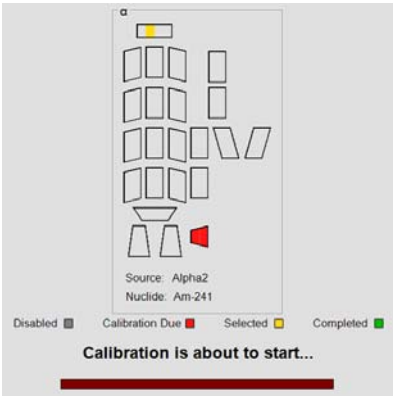


Once the background has been measured, position the sources:

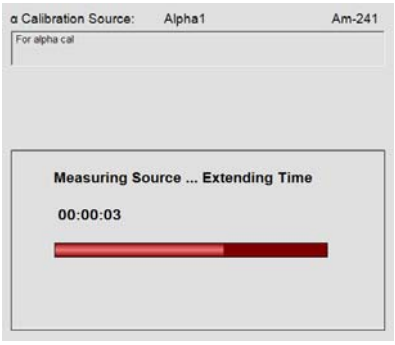




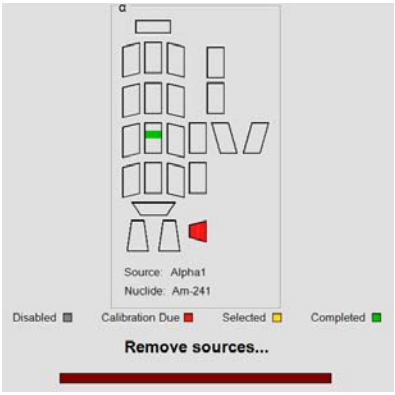
Once the iPCM detects the sources, the Calibration is about to start message is displayed. The display indicates where the source has been selected in yellow:



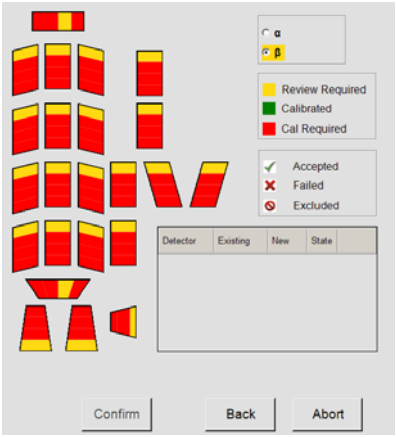
The source is now measured:



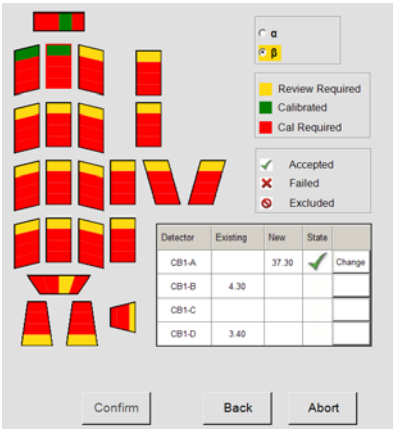
The display indicted which area has been completed in green:



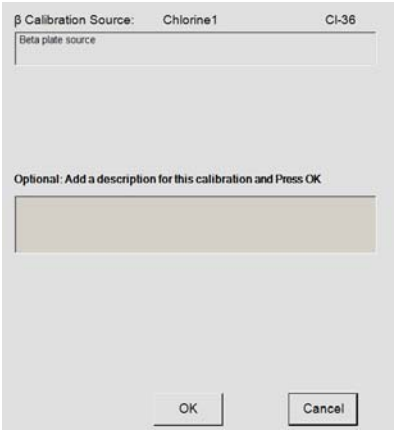
This process can be repeated as required. When completed, select the Done button to view a review of the process.



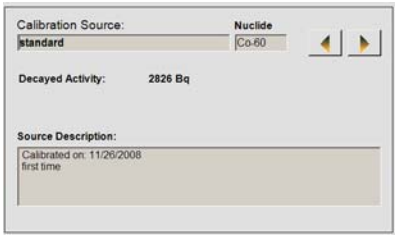
Click on a detector to see the new calibration details



When all the detectors have been accepted, the Confirm button can be pressed to display the Calibration Source description page:

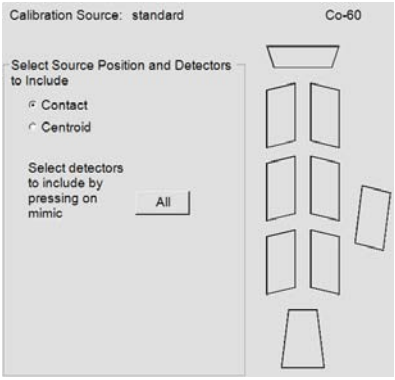


To Calibrate or Cal Check against γ, select a Radiation Type = γ and then press the Calibrate or Cal Check button. The following Calibration Single Source window is displayed.



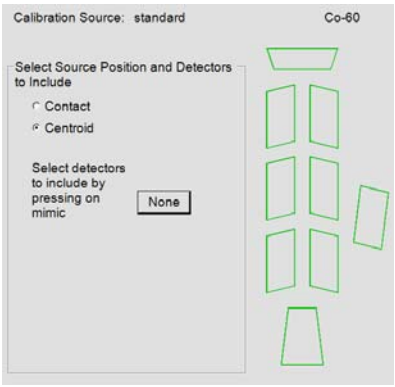
See Sources and Jigs (page 5-48) for more information regarding the setting up of Sources and Jigs.

Use the direction arrows to select a Calibration Source. Once selected, press Next button to view the Select Source Position and Detectors window:

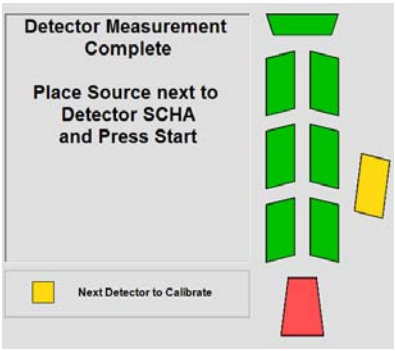


Select Contact or Centroid Source Position and then select All or None detectors to be included.

If All has been selected, the Detectors are highlighted in green:

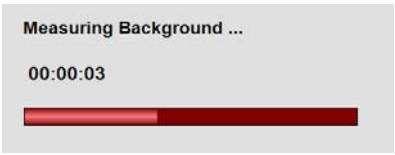


If None has been selected, the iPCM will instruct where the source is to be placed as follows:

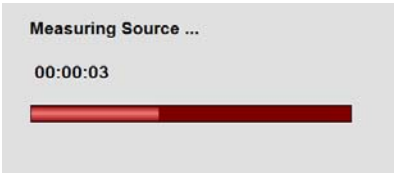


Press the Start button to continue:

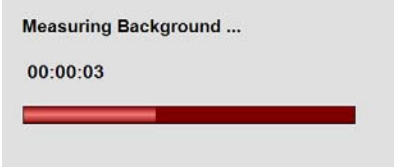
Press the Start button to commence the background measurement:



Once the Background Measurement has been completed, place the Source as instructed and press Start:

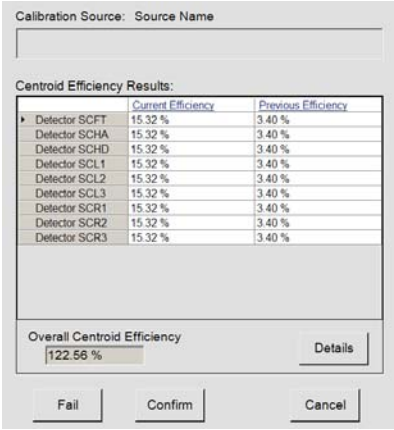


Once the Source Measurement has been completed, remove the Source as instructed and press Start:



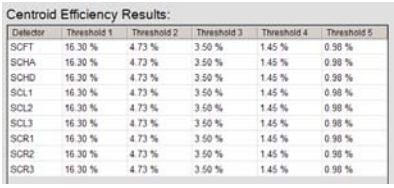
Once the second Background Measurement has been completed, the Results are displayed:

Note that during a Cal Check only an OK button is displayed which returns to the Calibration|Cal Check screen.



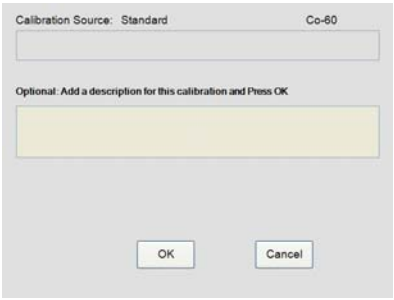
If the calculated efficiency has an illegal value (i.e. no net counts), the efficiency will be set to zero.

Select Details button to view details results:



If you are satisfied with the result, press the Confirm button to display the Add Description for the Calibration page. Select OK to complete the process.

Note that the results are stored in the database and marked as PASS.



If you are NOT satisfied with the result, press the Fail button. The Calibration Source page is re-displayed.

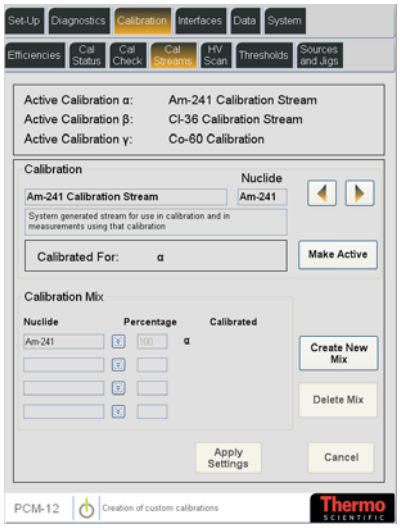
Note that the results are stored in the database and marked as FAIL.

Description of Error messages:

Error Message	Resolution
Unable to calculate a valid monitoring time	1. There is no source available 2. The source does not have enough activity 3. If a cobalt calibration has been activated and the source is not Co60
This is not the default Calibration Source	This is a warning message only

Cal Streams

Select Calibration|Cal Streams to view current Calibration and create new customised Calibrations.



Note that the Active Calibration is displayed in the top box.

To change the Active Calibration, use the direction arrows to select a Calibration. Once selected, press Make Active button. The selected Calibration will be displayed in the top box.

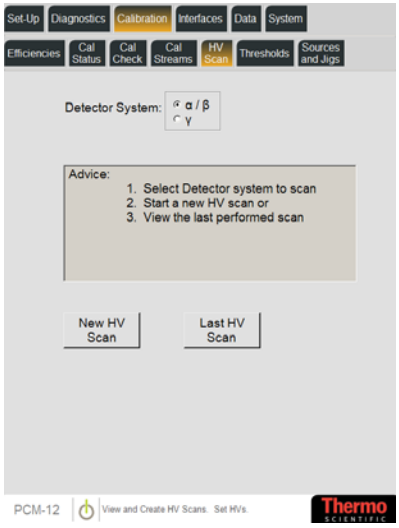
To edit a Calibration Mix, select a Calibration. Press in the Calibration field to edit the Calibration name. In the Calibration Mix section, use the drop-down list to change the Nuclide. Press in the Percentage field to edit the percentage. When complete, press Apply Settings button to save or Cancel button to quit without saving.

To create a new Calibration Mix, highlight in an empty Calibration Mix window (or an existing Calibration Mix to overwrite) and click on the Create New Mix button. Press in the Calibration field to create a new Calibration name. In the Calibration Mix section, use the drop-down list to add a new Nuclide. Press in the Percentage field to edit the percentage. When complete, press Apply Settings button to save or Cancel button to quit without saving.

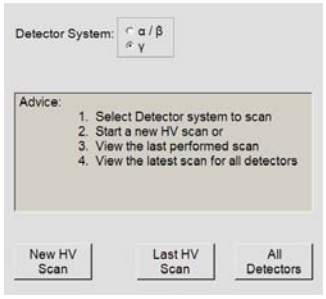
To delete an existing Calibration Mix, highlight the Calibration Mix for deletion and press the Delete Mix button.

HV Scan

Select Calibration|HV Scan to view and create HV Scans. It is also possible to set HVs for detector amplifiers. The scan allows repeated counts at an increasing or decreasing HV to be recorded to ascertain detector operating point and efficiency.



Note that if Detector System γ is selected, the following window is displayed:



To start a new HV Scan, press the New HV Scan button to display the Please enter scan Parameters window:

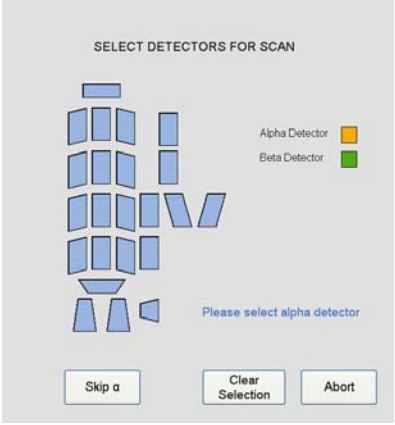
Description of options:

Field Name	Description
Minimum Voltage (V)	Enter a minimum voltage.
Maximum Voltage (V)	Enter a maximum voltage. *Note that this value should at least be Minimum Voltage + Step Size.*
Step Size (V)	Enter a step size for the scan.
Step Duration (s)	Enter the length (in seconds) for each step.

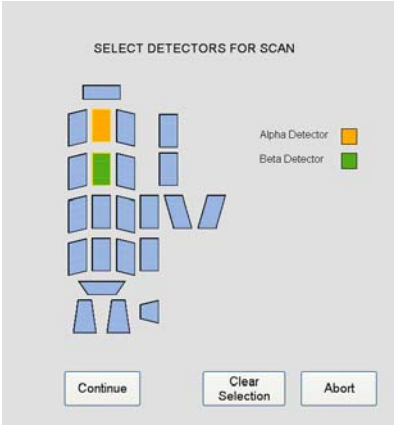
Once the above scan parameters have been established, two scans will be made against each amplifier threshold for all amplifiers at each HV step over the specified integration period:

- A background HV Scan
- A source HV Scan

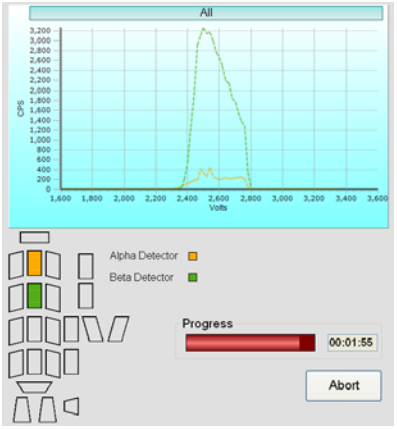
If Detector System α / β is selected, the Detectors for Scan window is displayed:



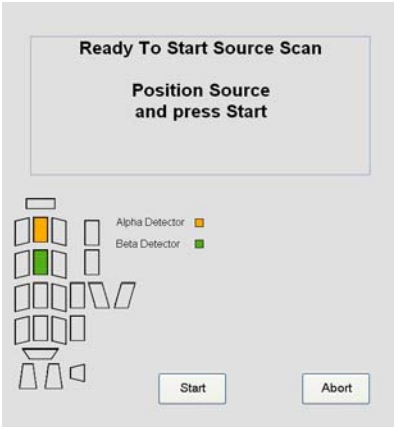
Select an alpha detector and then a beta detector (you can skip selecting a second detector by pressing the Skip α or β button). Select the Continue button to start the HV Scan:



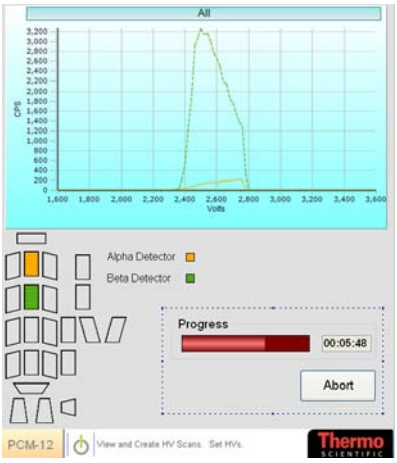
The background scan commences.



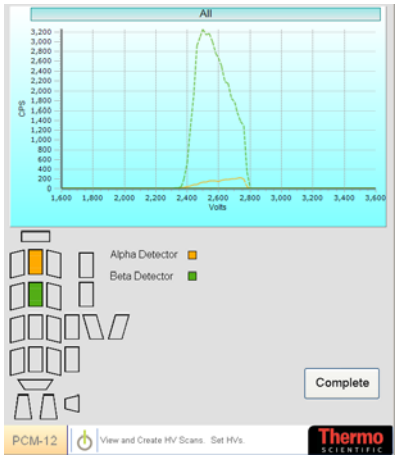
Once the Background Scan is completed, the Ready to Start Source Scan screen is displayed. Position the Source to be scanned in the iPCM12 and press the Start button. A source HV scan will be performed, recording the counts against **each amplifier threshold** for all amplifiers at each HV step over the specified integration period. A progress window is displayed:



The source scan commences.

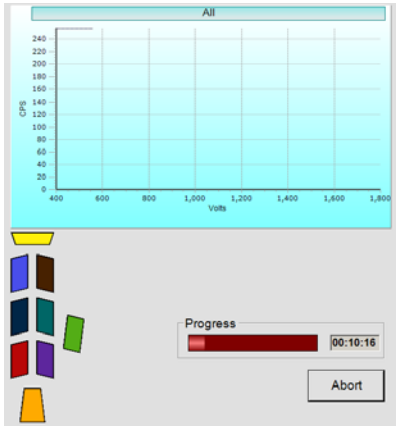


Once complete, the result is displayed. Select the Complete button to display the Scan Description window.

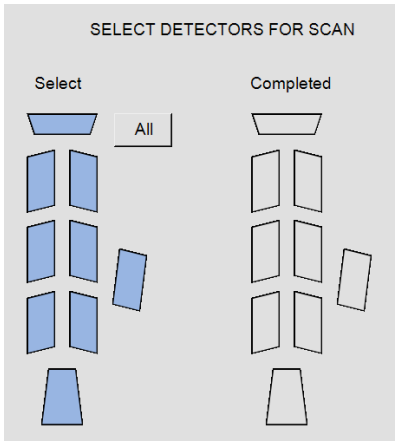


If Detector System γ is selected, the Ready to Start Background scan window is displayed:

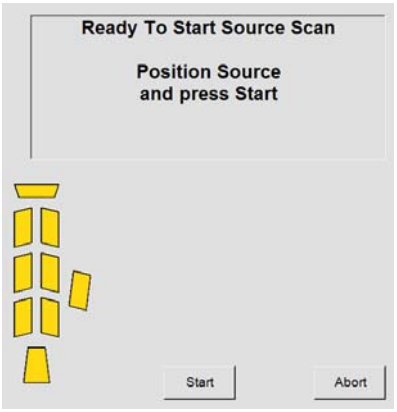
Press Start to commence the Background scan:



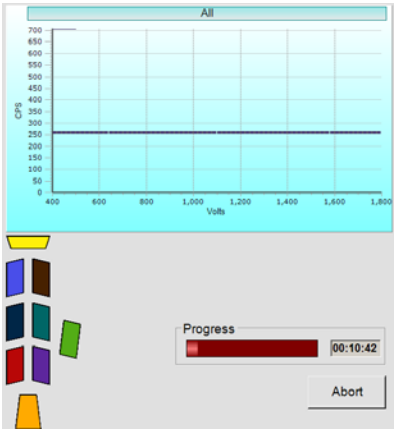
Once complete, the Select Detectors for Scan window is displayed:



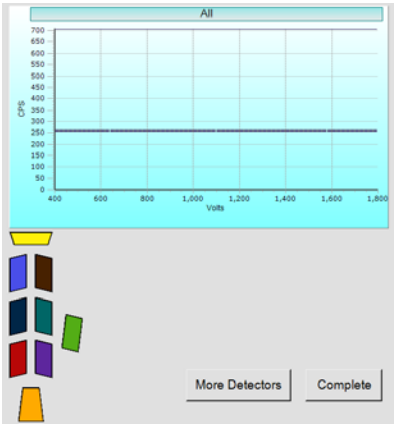
Once the individual or All Detectors have been selected, press the Continue button to display the Ready to Start Source Scan window:



Position the source and press the Start button. The Progress window is displayed as follow:



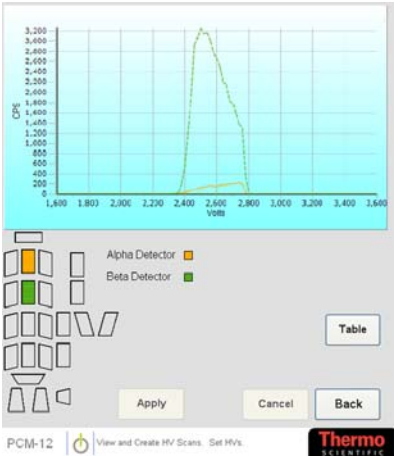
Once complete, the result is displayed. Select the Complete button to display the Scan Description window.



Once the Scan is completed (and the Complete button has been pressed), a Save Scan window appears giving the option to save the scan or Abort the process.

To Save the Scan, press Save to display the Please enter a scan description window:

Enter a Scan Description and press Save button to display the Scan results:



Select Apply button to save the Scan.

Press Cancel button to quit without saving or press Back button to return to the Start new scan screen.

To view the HV Scan as a Table, press the Table button to display the scan results.

To view the HV Scan as a Graph, press the Graph button to display the scan results.

To view the current Scan for all detectors, press the Current HV Scan button to display the scan results.

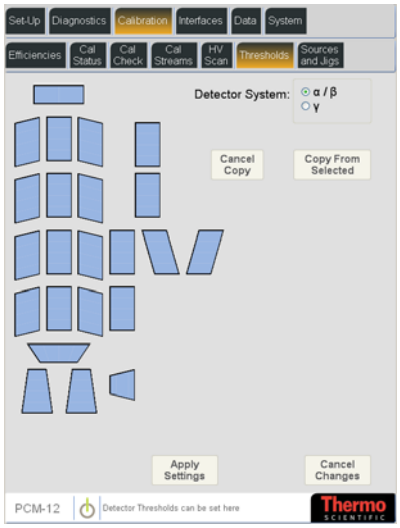
To view the last saved HV Scan, press the Last HV Scan button to display the scan results.

To view the latest scan for All Detectors, press the All Detectors button.

See Performing the HV Scan (page 9-5) for more information regard the HV Scan.

Thresholds

Select Calibration|Thresholds to set the Detector Thresholds:



This screen allows the individual voltage of any detector to be viewed and updated.

To change any of the settings, press on the detector field and update the value. Press Apply Settings button to save or Cancel Changes button to quit without saving.

To copy from a selected Detector, highlight the detector to copy from. Then press the Copy From Selected button. Select the detector(s) to paste to and press the Paste to All Selected button.

Note that no threshold value should be set to a voltage that is less than that of the preceding threshold. For example, Threshold 5 must be set greater than or equal to Threshold 4. Failure to follow this advice may invalidate measurements. Please contact Thermo Fisher Scientific before changing threshold values.

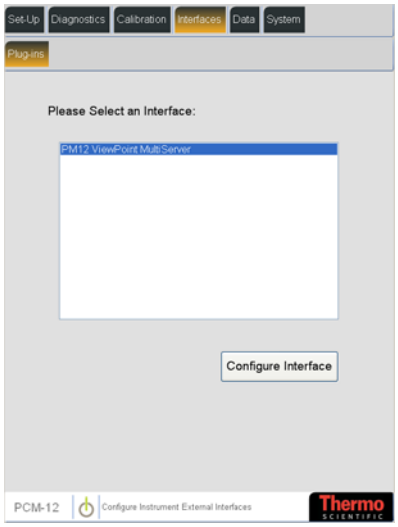
Sources and Jigs

Select Calibration|Sources and Jigs to create the calibration sources and jigs:

Interfaces

Plug-ins

Select Interfaces|Plug-ins to configure an interface to another system:



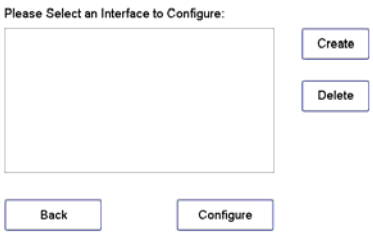
Note that interfaces are not limited to the examples given below. Other interfaces are possible and the parameters described below may vary according to the interface selected. Please contact Thermo Fisher Scientific regarding your specific interface requirements.

- IDS Camera – see IDS Camera (page 5-49)

For further information in setting up any of these Plug-ins, please contact Thermo Fisher Scientific.

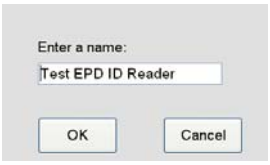
To configure an Interface

Highlight the Interface to configure and select the Configure Interface button:



Note that the selected type of interface is displayed in the top left hand corner.

The Create button allows the user to Create a new Interface.



The user is prompted to enter a name for the new Interface.

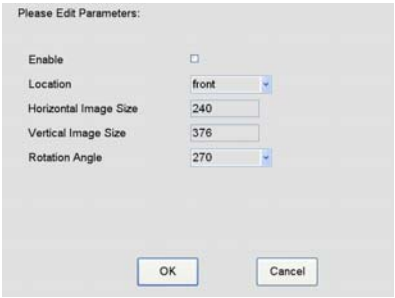
To delete an existing interface, highlight the Interface and press the Delete button. Select OK to continue.

The Configure button allows the user to configure an existing highlighted interface.

The Back button returns the user to the previous screen.

IDS Camera

Press the OK button to display the editable parameters for the IDS Camera:



Description of options:

Field Name	Description
Enable	Tick this option to enable the interface to work with the iPCM12.
Location	Use the drop-down button to select either front or rear.
Horizontal Image Size	Enter the horizontal image size (in mm).
Vertical Image Size	Enter the vertical image size (in mm).
Rotation Angle	Use the drop-down button to select either 0, 90, 180 or 270.

Cameras

Note that this option is only available if camera(s) have been installed (see IDS Camera (page 5-49)).

The current image is displayed on screen.

To adjust the Brightness, move the orange bar to decrease the brightness and to the right to increase the brightness.

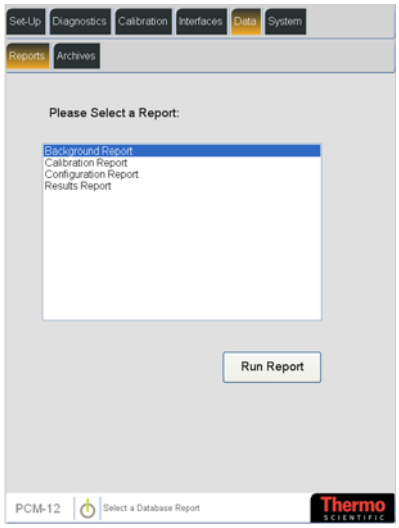
To adjust the Contrast, move the orange bar to decrease the contrast and to the right to increase the contrast. Tick the Auto button for automatic adjustment of the contrast.

To adjust the Gain, move the orange bar to decrease the gain and to the right to increase the gain. Tick the Auto button to automatically control the gain of a signal.

Data Menu

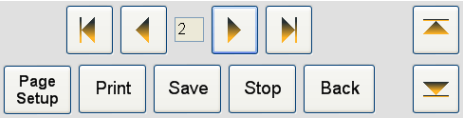
Reports

Select Data|Reports to select a Database Report from a pre-defined list:



To run a report, select one from the list and press the Run Report button. The types of Reports available are listed below. Each report can be limited by various parameters, e.g.

Each report displays the following button bar



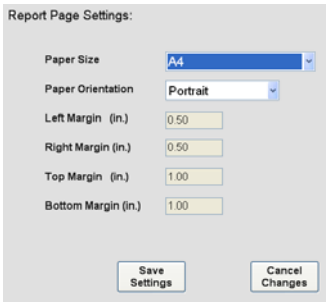
Report Button Functions

Direction Arrows steps through the report pages

Direction Arrows moves the report up and down

Page Setup

Page Setup display the Report Page settings:



Enter the required settings and press OK

Print

The Print button sends the report to the printer.

Save

The Save button displays the Drive selection window to allow you to select a Drive for the saved report. The report will be saved as an Excel spreadsheet with the following name:

<Report Type><YYMMDDHHMM>.xls

e.g.

ResultsReport0902261151.xls

Stop

Stop cancels the processing of the report.

Back

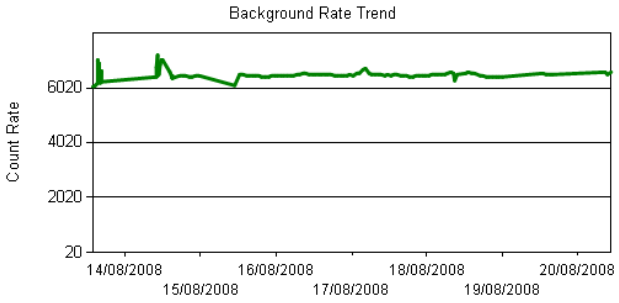
Back returns the user to the previous screen.

Background Report

This report shows the Background Rate Trend between the selected Start and End Dates. It is possible to limit the report by Start and End Date, Radiation Type (Alpha, Beta or Gamma) and Statistic (Max, Min, Mean).

Please note that the report below is an example and does not display all the information.

Background Measurement Summary



ID	Measurement Date	Count Rate	Changing	Integration Period
126	20/08/2008 10:29	6555	Yes	10
125	20/08/2008 09:23	6469	Yes	10
124	20/08/2008 08:41	6564	Yes	10
123	19/08/2008 16:02	6471	No	100
122	19/08/2008 15:05	6469	Yes	10
121	19/08/2008 13:56	6489	No	100
120	19/08/2008 12:56	6527	Yes	10
119	18/08/2008 23:54	6395	No	100

Press on one of the ID records to display the Background Measurement Detail for the selected Measurement ID:

Please note that the report below is an example and does not display all the information.

Background Measurement Detail

Background ID: 126 Date/Time: 20/08/2008 10:29

Detector	Threshold	Count Rate (cps)	Integration Period
1	1	727	10
1	2	176	10
1	3	168	10
1	4	74	10
1	5	37	10
2	1	812	10
2	2	147	10
2	3	139	10
2	4	62	10
2	5	24	10
3	1	859	10
3	2	159	10
3	3	155	10
3	4	64	10
3	5	23	10
4	1	738	10
4	2	127	10
4	3	121	10
4	4	44	10
4	5	18	10
5	1	909	10
5	2	164	10
5	3	151	10
5	4	68	10
5	5	25	10
6	1	699	10
6	2	117	10
6	3	110	10
6	4	39	10
6	5	19	10
7	1	858	10
7	2	141	10
7	3	133	10
7	4	53	10
7	5	20	10
8	1	953	10
8	2	170	10
8	3	160	10
8	4	72	10
8	5	35	10

Calibration Report

This report lists Calibration History for the iPCM12. It is possible to limit the report by Start and End Date, and Full Cal.

Calibration History

ID	Calibration Date	Source Types	Pass / Fail	Comments
64	08/07/2009 12:07:52	Gamma	Fail	Calibration Check Only
63	08/07/2009 12:05:42	Gamma	Fail	Calibration Check Only
62	08/07/2009 12:00:50	Gamma	Pass	Calibration Check Only
61	08/07/2009 11:16:40	Gamma	Pass	Calibration Check Only

Page 1 Of 1

Press on one of the ID records to display the Calibration Efficiencies for the selected Calibration ID:

Calibration Efficiencies

Calibration ID: 64 Calibration Date: 08/07/2009 12:07:52

Confidence: 1.00

Accuracy: 5.00 %

Calibration Check Only

Source Name	Nuclide	Emission Type	Decayed Activity (Bq)
standard	Co-60	Gamma	2768

Detector		Threshold	Activity Efficiency (%)
SCFT	Centroid		
		1	0.00
		2	0.00
		3	0.00
		4	0.00
		5	0.00

SCHA	**Centroid**		
		1	0.00
		2	0.00
		3	0.00
		4	0.00
		5	0.00
SCHD	**Centroid**		
		1	0.00
		2	0.00
		3	0.00
		4	0.00
		5	0.00
SCL1	**Centroid**		
		1	0.00
		2	0.00
		3	0.00
		4	0.00
		5	0.00
SCL2	**Centroid**		
		1	0.00
		2	0.00
		3	0.00
		4	0.00
		5	0.00
SCL3	**Centroid**		
		1	0.00
		2	0.00
		3	0.00
		4	0.00
		5	0.00
SCR1	**Centroid**		
		1	0.00
		2	0.00
		3	0.00
		4	0.00
		5	0.00
SCR2	**Centroid**		
		1	0.00
		2	0.00
		3	0.00
		4	0.00
		5	0.00
SCR3	**Centroid**		
		1	0.00
		2	0.00
		3	0.00
		4	0.00
		5	0.00

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Configuration Report

This report lists the current Instrument Configuration settings.

Please note that the report below is an example and does not display all the information.

Configuration Settings on 26 February 2009

Instrument: IPCM-002

Configuration Item	Value
Alarm Requires Supervisor Acknowledge	No
AlphaAlarmsEnabled	Yes
AlphaBodyPod	3.1
AlphaBodyPodKey	3.1
AlphaBodyPofa	1.65
AlphaBodyPofaKey	1.65
AlphaDetectionEnabled	Yes
AlphaFootPod	3.1
AlphaFootPodKey	3.1
AlphaFootPofaKey	1.65
AlphaFootPofay	1.65
AlphaHandPod	3.1
AlphaHandPodKey	3.1
AlphaHandPofa	1.65
AlphaHandPofaKey	1.65
AlphaHighBackgroundLimit	10000
AlphaLowBackgroundLimit	0
AlphaPurgeDuration	30
Portal Approach Time (s)	2
BackgroundPeriod	200
Background Logging Interval (hours)	2
BackgroundStabilityRatio	0.5
BetaAlarmsEnabled	Yes
BetaBodyPod	3.1
BetaBodyPodKey	3.1
BetaBodyPofa	1.645
BetaBodyPofaKey	1.65
BetaDetectionEnabled	Yes
BetaFootPod	3.1
BetaFootPodKey	3.1
BetaFootPofa	1.65
BetaFootPofaKey	1.65
BetaHandPod	3.1
BetaHandPodKey	3.1
BetaHandPofa	1.65

BetaHandPodKey	3.1
BetaHandPofa	1.65
BetaHandPofaKey	1.65
BetaHighBackgroundLimit	10000
BetaLowBackgroundLimit	0
BetaQuickScanEnabled	No
Cal Check Required Interval (days)	0
Default Calibration Accuracy (%)	0.5
Default Calibration Confidence (%)	3

Configuration Item	Value
Gross Changing Background Sigma	5
Changing Conditions Sigma	4
Detector Changing Background Sigma	7
Changing Conditions Check Period	2
Co60 Alarms Enabled	No
Complete All Steps	Yes
Background Data Retention (months)	12
Calibration Check Data Retention (months)	3
Calibration Data Retention (months)	24
Event Log Data Retention (months)	6
Results Data Retention (months)	6
DefaultAlphaBetaCalCheckSourceType	0
DefaultAlphaCalibrationSource	
DefaultBetaCalibrationSource	
Default Calibration Source	
DefaultCalReviewTolerance	5
DefaultGammaCalibrationSource	
Probability of False Alarm	3.1
Probability of Detection	1.65
Probability of Detection	1.65
Alarm Duration After Exit (s)	10
GammaAlarmsEnabled	No
GammaBodyPod	3.1
GammaBodyPodKey	3.1
GammaBodyPofa	1.65
GammaBodyPofaKey	1.65
GammaDetectionEnabled	No
GammaFootPod	3.1
GammaFootPodKey	3.1
GammaFootPofa	1.65
GammaFootPofaKey	1.65
GammaHandPod	3.1
GammaHandPodKey	3.1
GammaHandPofa	1.65
GammaHandPofaKey	1.65
GammaHighBackgroundLimit	10000
GammaLowBackgroundLimit	30
GammaOptionFitted	No
GammaQuickScanEnabled	No

GasFlowSumZonesEnabled	No
HighAlarmsEnabled	No
HighAlarmsMultiplier	3
ID Timeout (s)	10
Instrument Contaminated	No
Language	en-GB
Location	Not Set

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Events Report

This report lists the Event History details between the selected Start and End dates. It is possible to limit the report by Start and End Date.

Please note that the report below is an example and does not display all the information.

Event History

Event Time	#	Description	Additional Info	Category
08/07/2009 15:10:47		Recovered From Out Of Service		Info
08/07/2009 15:10:45		Out of Service (Recoverable)		Info
08/07/2009 15:10:45		High Background Conditions Detected		Info
08/07/2009 14:50:37	7	Instrument Parameters Changed		Info
08/07/2009 11:19:40		Recovered From Out Of Service		Info
08/07/2009 11:19:34		Out of Service (Recoverable)		Info
08/07/2009 11:19:34		Low Background = TH-A		Info
07/07/2009 11:28:25	3	Instrument Parameters Changed		Info
07/07/2009 11:28:07		Recovered From Out Of Service		Info
07/07/2009 11:28:00		Out of Service (Recoverable)		Info
07/07/2009 11:28:00		Low Background = TH-A		Info
07/07/2009 11:27:05		Recovered From Out Of Service		Info
07/07/2009 11:26:51		Out of Service (Recoverable)		Info
07/07/2009 11:26:51		Low Background = TH-A		Info
07/07/2009 11:26:26		Recovered From Out Of Service		Info
07/07/2009 11:26:05		Out of Service (Recoverable)		Info
07/07/2009 11:26:05		Low Background = TH-A		Info
07/07/2009 10:48:55		Instrument Parameters Changed		Info
07/07/2009 10:09:49		Instrument Starting Up		Info

Page 1 Of 1

Results Report

This report lists the Activity Results between the selected Start and End dates. It is possible to limit the report by Start and End Dates, by the last n results (note enter 0 for unlimited results), Alarms Only, Person ID and Show Raw Counts:

Activity Results Summary

Result ID	Person ID	Result Date	Alarmed	Result Type
68		23/02/2009 09:16	No	
67		23/02/2009 09:15	Yes	Standard
66		19/02/2009 17:31	No	
65		05/02/2009 15:06	Yes	Standard
64		04/02/2009 16:39	No	
63		04/02/2009 16:10	No	
62		04/02/2009 16:10	Yes	Standard
61		04/02/2009 16:09	No	
60		04/02/2009 16:08	No	
59		04/02/2009 16:07	No	

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Press on one of the ID records to display the Activity Results Detail for the selected Results ID:

Please note that the report below is an example and does not display all the information.

Activity Results Detail

Result ID: 67

Date: 23/02/2009 09:15:45

Person ID:

Result Type: Contaminated

Monitor Time (s): 8

Quickscan Time (s): 8

Measurement Confidence: 2

Measured Values

Radiation Type	Measured Value	Uncertainty	Detection Limit	Units	Stream Name
Alpha	1.1	0.751	2.67	Bq	Co-60 Calibration
Beta	3.53	2.16	5.92	Bq	Co-60 Calibration

Alarms:

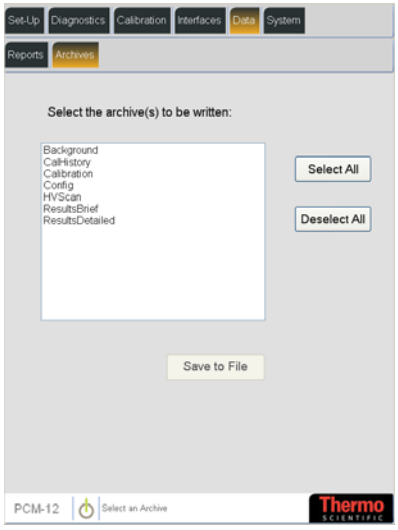
Detector / Zone	Position	Alarm Type	Background Rate (cps)	Net Count Rate (cps)	Effective Alarm Level (cps)	Alarm Multiple	Alpha / Beta counts
RB3-A	Facing Front	Alpha	0	1	1.1	1	

Raw Counts:

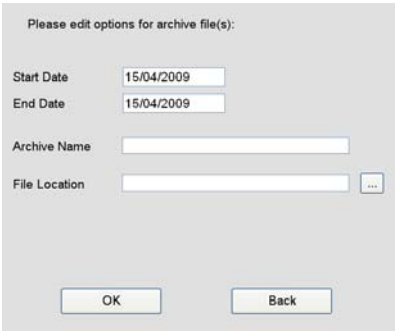
Detector	Threshold	Gross Count Rate (cps)	Background Count Rate (cps)	Net Count Rate (cps)
AR-A	1	5.9	5.5	0.3
AR-A	2	2.1	1.6	0.5
AR-A	3	0	0	0
AR-A	4	0	0	0
AR-A	5	0	0	0
AR-A-2	1	6.9	5.5	1.3
AR-A-2	2	1.8	1.6	0.2
AR-A-2	3	0.3	0	0.2
AR-A-2	4	0.3	0	0.2
AR-A-2	5	0	0	0
AR-B	1	7	5.6	1.4
AR-B	2	2.6	1.6	1
AR-B	3	0.1	0	0.1
AR-B	4	0.1	0	0.1
AR-B	5	0	0	0
AR-B-2	1	6.5	5.6	0.9
AR-B-2	2	2.4	1.6	0.8
AR-B-2	3	0.4	0	0.4
AR-B-2	4	0.4	0	0.4
AR-B-2	5	0	0	0
AR-C	1	7.6	5.7	1.9
AR-C	2	1.8	1.5	0.2
AR-C	3	0.1	0	0.1
AR-C	4	0.1	0	0.1
AR-C	5	0	0	0
AR-C-2	1	4.9	5.7	-0.8
AR-C-2	2	1.1	1.5	-0.4
AR-C-2	3	0	0	0
AR-C-2	4	0	0	0
AR-C-2	5	0	0	0
AR-D	1	6.5	5.9	0.6
AR-D	2	1.8	1.9	-0.1
AR-D	3	0	0.1	-0.1
AR-D	4	0	0.1	-0.1
AR-D	5	0	0	0
AR-D-2	1	5.8	5.9	-0.1
AR-D-2	2	1.4	1.9	-0.5
AR-D-2	3	0	0.1	-0.1
AR-D-2	4	0	0.1	-0.1
AR-D-2	5	0	0	0
CB1-A	1	6.4	5.4	0.9
CB1-A	2	1.5	1.4	0.1
CB1-A	3	0	0	0
CB1-A	4	0	0	0
CB1-A	5	0	0	0
CB1-A-2	1	4.1	5.4	-1.3

CB1-A-2	2	1.6	1.4	0.2
CB1-A-2	3	0	0	0
CB1-A-2	4	0	0	0
CB1-A-2	5	0	0	0
CB1-B	1	6.4	5.7	0.7
CB1-B	2	2	1.4	0.6
CB1-B	3	0	0	0
CB1-B	4	0	0	0
CB1-B	5	0	0	0
CB1-B-2	1	5.3	5.7	-0.4
CB1-B-2	2	1.5	1.4	0.1
CB1-B-2	3	0	0	0
CB1-B-2	4	0	0	0
CB1-B-2	5	0	0	0
CB1-C	1	6.8	5.4	1.4
CB1-C	2	2.4	1.6	0.8
CB1-C	3	0	0	0
CB1-C	4	0	0	0
CB1-C	5	0	0	0
CB1-C-2	1	6.9	5.4	1.5
CB1-C-2	2	2.1	1.6	0.5
CB1-C-2	3	0	0	0
CB1-C-2	4	0	0	0
CB1-C-2	5	0	0	0
CB1-D	1	5.4	5.5	-0.1
CB1-D	2	1.4	1.3	0.1
CB1-D	3	0	0	0
CB1-D	4	0	0	0
CB1-D	5	0	0	0
CB1-D-2	1	5.4	5.5	-0.1
CB1-D-2	2	1.6	1.3	0.3
CB1-D-2	3	0	0	0
CB1-D-2	4	0	0	0
CB1-D-2	5	0	0	0
CB2-A	1	4.4	5.5	-1.1

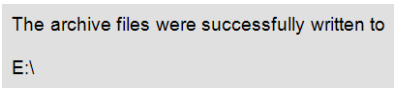
Archives Select Data|Archives to select an Archive to be saved:



To select archives to be saved, highlight the archive on the screen by pressing individual names or press the Select All button. Press the Save to File button to display the edit options window:



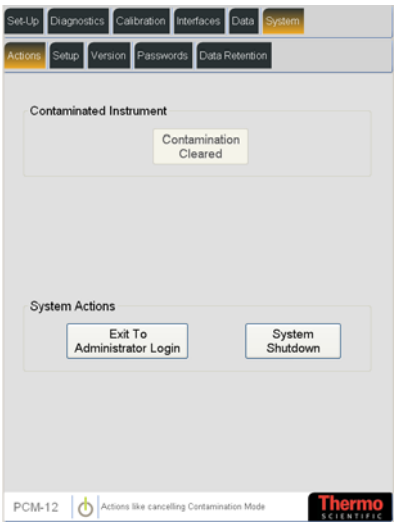
Select a Start / End Date and enter an Archive Name and File Location. Select the OK button to write the archives. A confirmation will be displayed.



System Menu

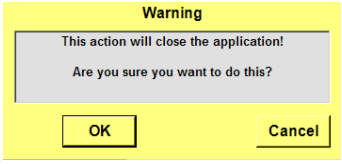
Actions

Select System|Actions to take iPCM12 out of Contamination Mode, quit the application or shutdown the system

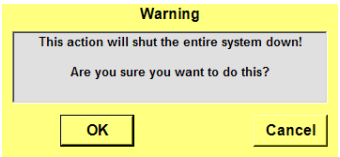


To clear a contamination, press the Contamination Cleared button.

To exit the iPCM12 application, press the Exit to Application Login button. A confirmation message will be displayed. Select OK to close the application.

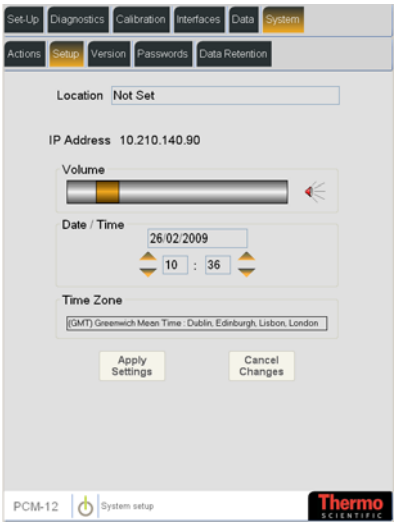


To shutdown the entire system, press the System Shutdown button. A confirmation message will be displayed. Select OK to shut the entire system down.



Setup

Select System|Setup to set the location, volume, date / time and time zone



To change the Location, enter the location using the alpha-numerical field.

Note that the IP address is displayed on this screen.

To adjust the volume, move the orange bar to the left to decrease the volume and to the right to increase the volume. To test the volume, press on the loudspeaker icon. See Notes regarding Volume Levels (page 5-63).

To change the Date, press on the date field and select a date. Note that the format of the date depends on the Language type selected in Options screen - see UI Options (page 5-8). Select the Apply Settings button to save.

To change the Time, use the Up/Down buttons to change the hours and minutes. Select the Apply Settings button to save.

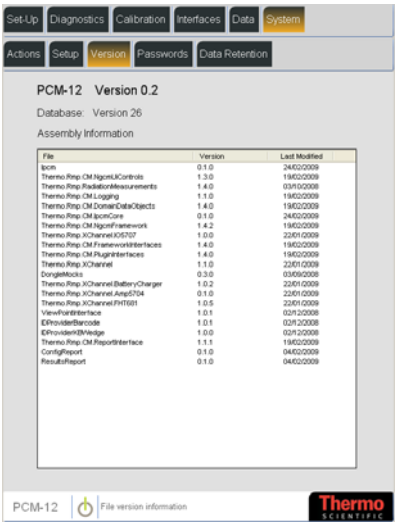
To change the Time Zone, press on the TimeZone field and select a time zone from the pre-defined list. Select the Apply Settings button to save.

Notes regarding Volume Levels

For guidance, 85dBA is obtained at about 35% volume control level and 100dBA at 100% volume control level.

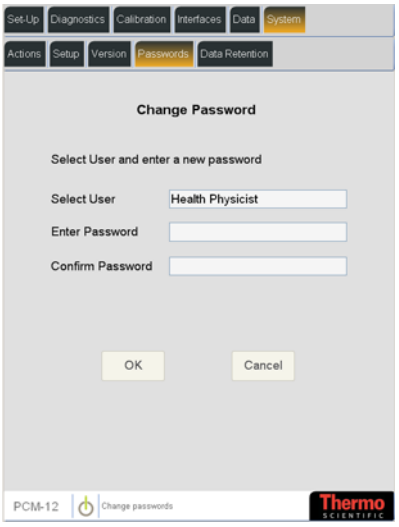
Version

Select System|Version to view the File version information, including the iPCM12 Issue and Version numbers



Passwords

Select System|Passwords to change the passwords for the current User Level and levels below



There are three levels of user – Health Physicist, Technician and ThermoFisher. The iPCM12 is supplied with unique default passwords for each level as follows:

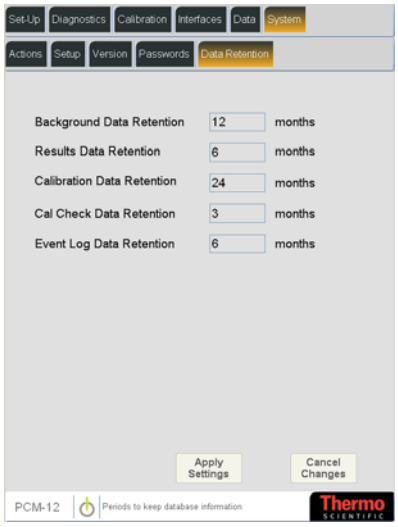
User	Password
Health Physicist	"hp"
Technician	"tech"
ThermoFisher	Contact Thermo Fisher Scientific

To change the Password for a select User, press in the Select User field to display the user roles. Select a User and select OK. Enter a Password and confirm the Password.

Ensure each password level has a unique Password – under no circumstances should all three roles be assigned the same password.

Data Retention

Select System|Data Retention to save the specified data for a set number of months



Enter the length in time (months) for how long each type of data is to be retained. Data is automatically deleted that is older than the specified time. The following data types are displayed:

- Background Data Retention (months)
- Results Data Retention (months)
- Calibration Data Retention (months)
- Cal Check Data Retention (months)
- Event Log Data Retention (months)

User Mode

The basic operation of the iPCM12 is as follows:

- Upon power up, system diagnostics are run – see Start Up Checks (page 5-71).
- Upon successful system diagnostics, the iPCM12 establishes a new Background – see Establishing a new Background (page 5-73).
- The system enters the Background Monitoring Mode – see Normal Background Monitoring (page 5-75).
- To commence monitoring, the user enters the portal – see Entering the Portal (page 5-78).
- Monitoring starts when the user is correctly positioned in the portal – see Commence Monitoring (page 5-81).
- At end of the first monitoring position, the instrument may either:
    1. Indicate any contamination and halt the measurement
    2. If Complete Both Steps is selected (see Operation (page 5-10)), monitoring continues
- Monitoring may be interrupted due to the result of a Quick Scan assessment (see Operation (page 5-10)), or if a significant change in background conditions is detected during the measurement – see Background Change during Measurement (page 5-86).
- At the end of the Monitoring period, activity is calculated and compared against a set of alarm thresholds for any combination of alpha, beta or gamma. A simple GO/NO GO indication is given optional display of the details of the location and level of contamination. – see Monitoring Result (page 5-87).
- Upon completion of monitoring, the user exits the portal - see Exiting the Portal (page 5-96).

User Screen

An example of the iPCM12 screen is displayed below:

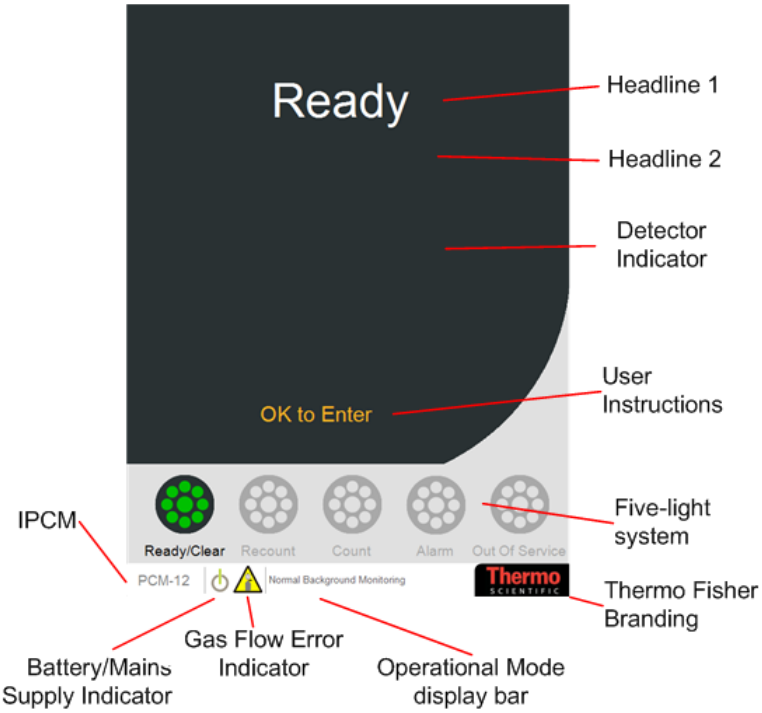
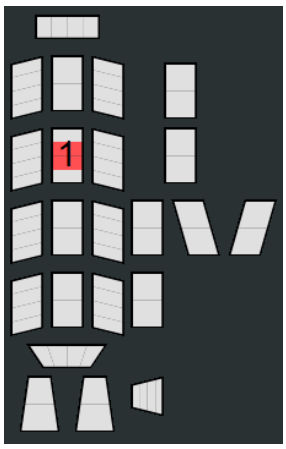


Figure 2 Example of iPCM12 User Screen

The iPCM12 User Screen displays the following:

- Headline 1 and 2 - note that some of these messages are user-definable - see Messages (page 5-24)
- Detector Indicator – displays where contamination occurs (if present) (see Detector Indicator (page 5-68))
- User Instructions - note that some of these messages are user-definable (see Messages (page 5-24))
- Five-light system which mimics the Annunciator Overlay display (see Five Light System (page 5-68))
- Thermo Fisher Scientific branding
- Operational Mode display bar – this also gives a description of the selected menu in Administration Mode
- Battery/Mains Supply Indicator (page 5-101)
- Gas Flow Error Indicator (page 5-21)
- iPCM12 – press here to enter Administrator Mode (page 5-1).

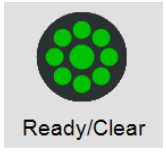
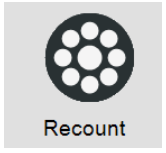
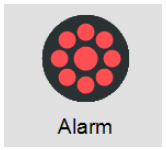
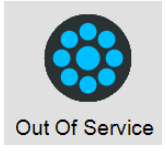
Detector Indicator



Following a measurement, if a contamination is present, the lit detectors will identify where the contamination has occurred (see Selecting Detectors (page 5-6) for more information regarding detectors)

Five Light System

The Five-Light system gives a visual indication of the current operation of the iPCM12.

	Solid	The iPCM12 is READY for operation
	+ Amber	The result of a measurement is CLEAR.
	Solid	A recount is necessary
	+ Red	User must exit portal before re-entering
	Solid	A measurement is in progress
	Flashing	User must move to next measurement position
	+ Green	Measurement Complete – Result CLEAR
	Solid	An alarm or violation has taken place during measurement OR The iPCM12 is contaminated
	+ White	User must exit portal before re-entering – accompanied by Alarm.
	+ Blue	Out of Service – Portal Occupied
	Solid	The iPCM12 is not in use.
	Flashing	Out of Service – Acquiring new background
	Fast Flashing	Out of Service – High or Low background
	+ Red	Out of Service – Portal Occupied
	Flashing + Red	Background Acquision suspended – accompanied by Alarm

Guidance System

The Guidance system gives a visual indication of the current operation of the iPCM12.

Position Body	This LED is lit if the user is not correctly positioned.
Turn Around	This LED is lit when the user is instructed to turn around.
Time Remaining	This LED gives an indication of how much time is remaining for the measurement.

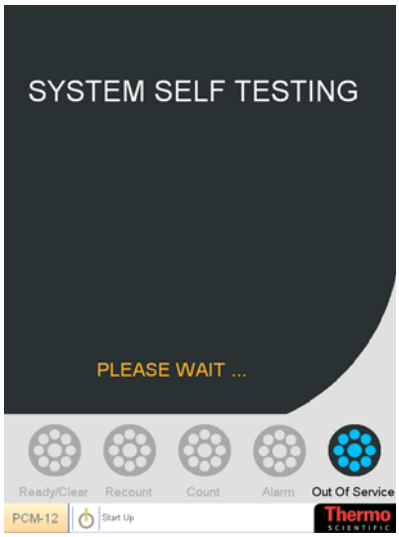
Voice Prompts

Note that if Voice Prompts are enabled (see UI Options (page 5-8)), instructions are given verbally. If Voice Prompts is not enabled, an Audible Indication is sounded. See Audible Indications (page 3-8) for further information.

Switch On

Cold Start State

When the iPCM12 unit is powered on, the "SYSTEM SELF TESTING" message is displayed.



In this state, diagnostics are run to validate the state of the iPCM12 to include:

- Database connectivity check. (Check local database is available)
- Instrument Configuration Data validation
- Instrument Configuration
- XChannel device communication test (check communication with each peripheral)

Note that after exiting from Administration Mode when an update to the configuration has been made (e.g. change to detector fit or replacement of an amplifier), the Cold Start Mode is entered.

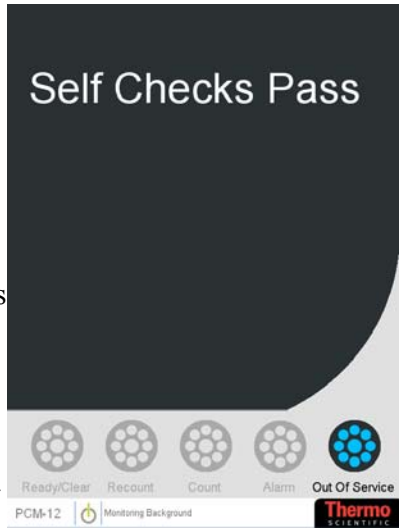
Self Test State

Following the Cold Start checks, the Self Test checks are run.

In this state, additional self tests and configuration are run to validate the state of the iPCM12 to include:

- Selected calibration validity checks. (Check efficiency factors are available for all detectors and that at least one valid alarm is set)

- Loading detector models with efficiencies and alarm thresholds.

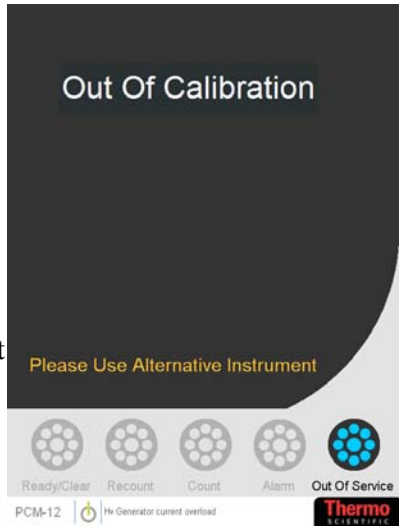


Upon successful completion of the tests and if beta detection is enabled (see Detection Options (page 5-16)), the gas flow detectors are tested for stability while the gas flow is increased to a purge level.

When all gas flow detectors are proved stable, the gas flow is reduced to normal and the current status of the background will be tested.

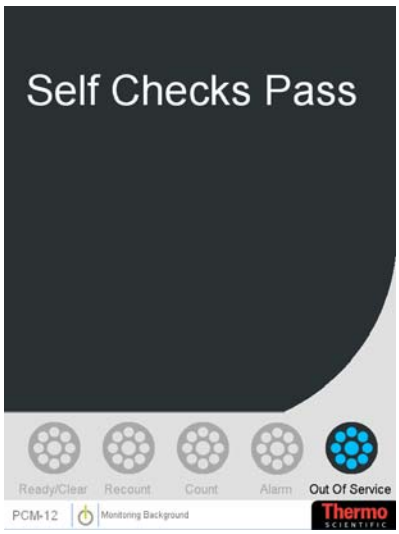
If valid, normal background monitoring will resume (see Normal Background Monitoring (page 5-75)).

If not valid, background stabilisation mode will be entered (see Background Stability Check (page 5-72)).

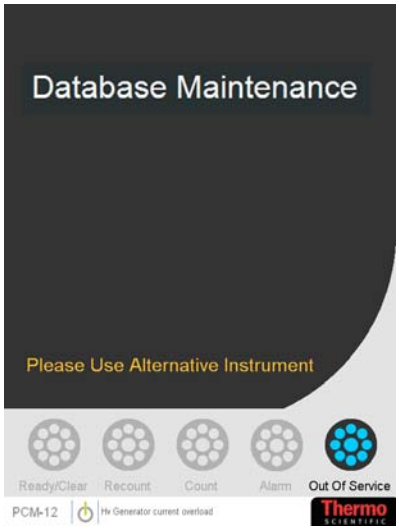


Start Up Checks

If the System Self Testing passes, the "Self Checks pass" message is displayed for a few seconds.



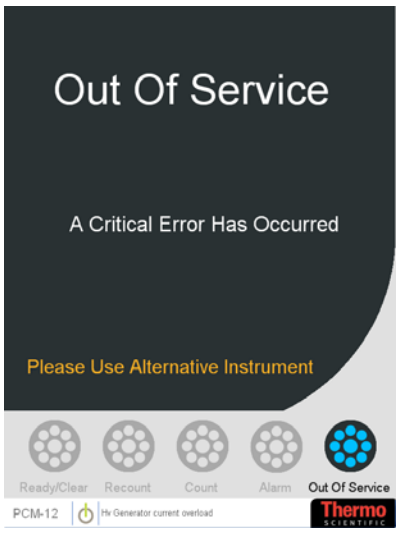
Database connectivity check, i.e. check that the local database is available.



If the System Self Testing fails, the "Out of Service – Critical Error" message is displayed (note that the reason for the error may be displayed in the message bar at the bottom of the screen).

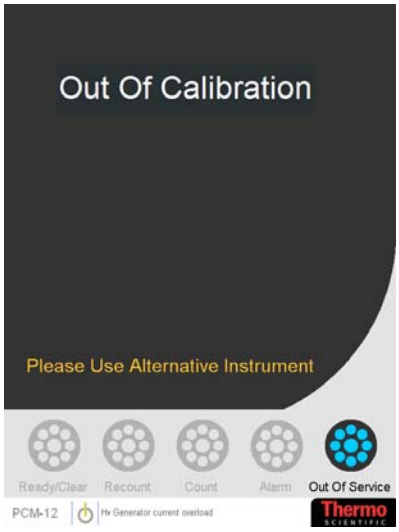
See Out Of Service (page 5-97).

See Maintenance and Trouble Shooting (page 11-1) for further information regarding the Self Test Failures messages.

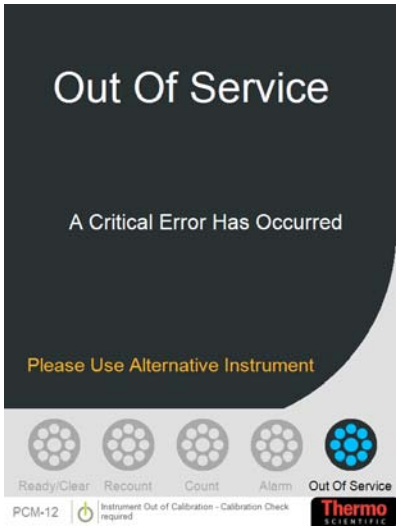


Out of Calibration

If the Calibration Warn Period has been reached, then the "Calibration Warning" message is displayed – see Calibration (page 5-15). To check the Calibration of the unit, see Cal Check (page 5-34).

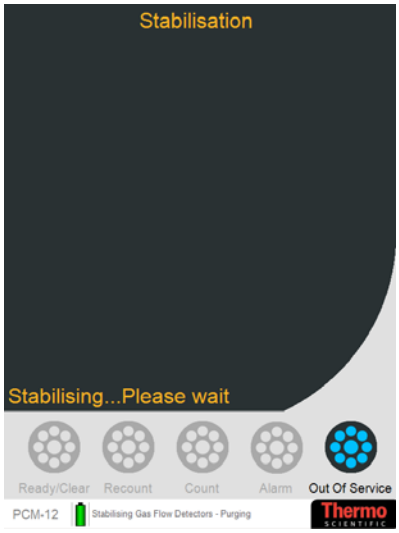


If the Calibration Required Interval option has been exceeded, then the "Out of Service" message is displayed (note that the reason given for Out of Service is displayed in the Operational Mode Display Bar)– see Calibration (page 5-15). To check the Calibration of the unit, see Cal Check (page 5-34).

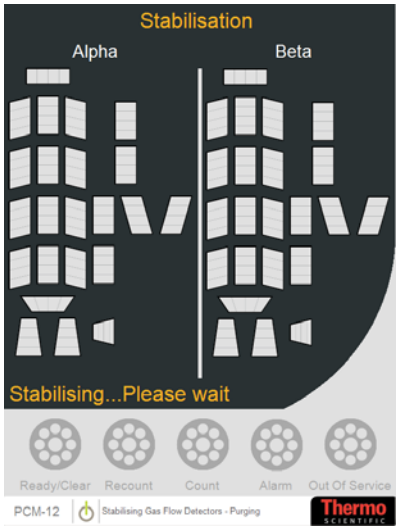


Background Stability Check

If beta detection is enabled (see Detection Options (page 5-16)), the gas flow detectors are tested for stability by increasing to a purge level.



Once these detectors are proved stable, the gas flow is reduced to normal and the current Background Status is tested.



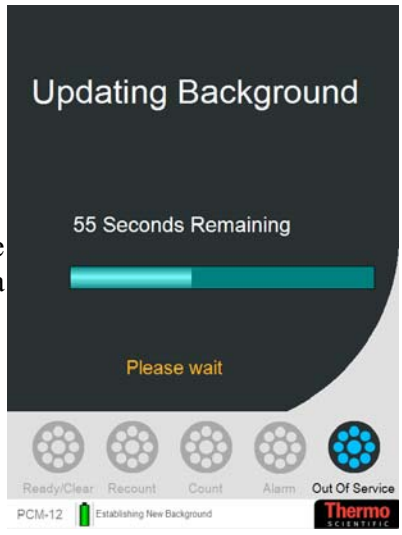
Establishing a new Background

Once the Self Checks have passed, iPCM12 will to acquire a new background and the "Updating Background" message is displayed.

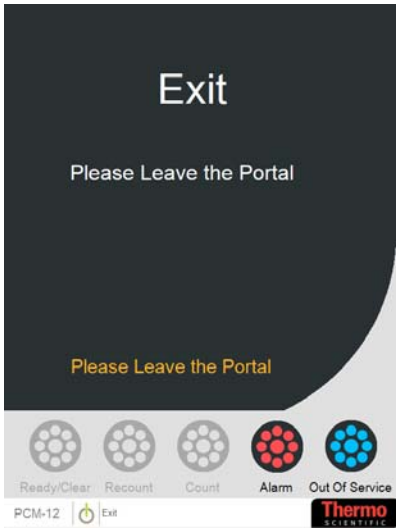
See Notes regarding Changing Background (page 5-78) for more information regarding acquiring a background.

Note: If Quick Background is enabled (see Operation (page 5-10), the length of time taken to acquire a new background will be much shortened (see Notes regarding Normal Background Monitoring (page 5-76)).

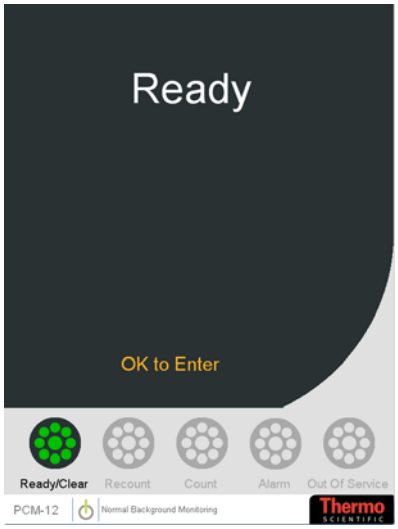
If the background changes during the establishment of a new background, the process will be restarted.



If the portal is entered when the iPCM12 is establishing a new background, background counting stops, the "Warning Portal is busy" message is displayed and an audible alarm will sound. To continue with the process, the portal must be vacated.

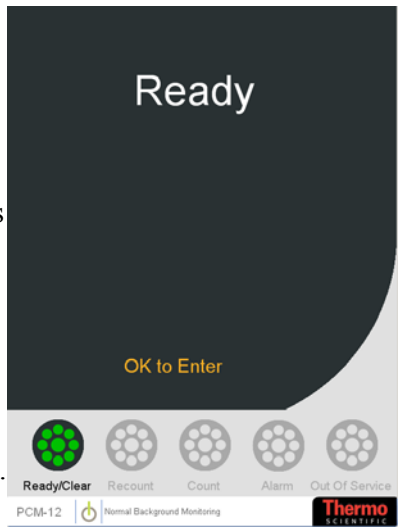


When a new Background has been established, the "Ready – OK to Enter" message is displayed. The iPCM12 is now ready to start monitoring contamination.



Normal Background Monitoring

This is the normal dormant state of the system. Normal Background Monitoring is continuous until:



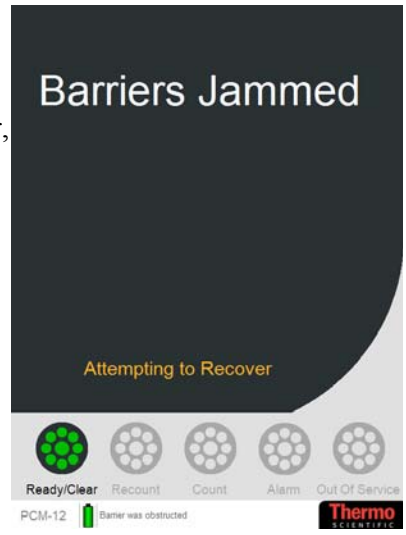
1. One or more of the position sensors are triggered (probably as part of a measurement cycle) – see Entering the Portal (page 5-78) for more information.

2. A change in background is detected – see Changes to the Normal Background Monitoring (page 5-76) for more information.

3. A high background condition is detected - see Notes regarding High Background (page 5-99) for more information.

If the Barrier Enabled and the Ingress Closed When Ready options are selected (see Detection Options (page 5-16)), the user is unable to pass through the barrier while the Ready message is displayed.

If there is a problem with the Door / Barrier, the "Barriers Jammed" message is displayed. If the system is unable to recover, the Out of Service message is displayed (see Barrier Error (page 5-98)).



Notes regarding Normal Background Monitoring

Alpha and Beta Backgrounds

The backgrounds will be monitored over a 100 second period in 10 second blocks. At the end of each 10 second accumulation, the 10 second background will be compared with the prevailing 100 second background to assess for changing background or counts out of range conditions on the detectors before adding it into the current 100 second background.

Gamma Backgrounds

The background will be monitored over 1 second check periods. Each 1 second period will contribute to a rolling average of up to 100 periods.

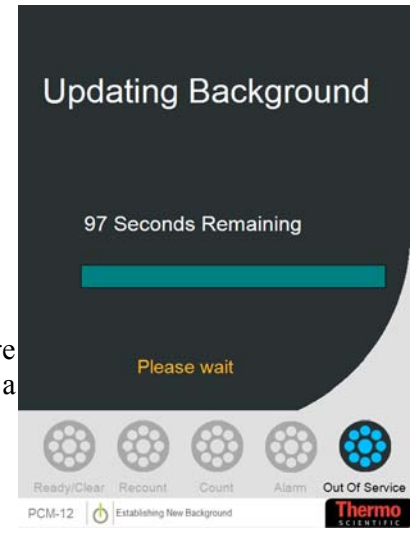
Because a contaminated user approaching the instrument may affect the background of the instrument, all background counts are pre-buffered for the Portal Approach Time (see Operation (page 5-10)) before being incorporated into the main background of the instrument. When a person is detected entering the instrument, these pre-buffered background counts are discarded.

Quick Background

The background accumulation period is dynamic. The instrument will remain "Out of Service" for as long as it takes to acquire a stable background and results in a count time lower than the Maximum Monitoring Time (see Monitoring (page 5-12)).

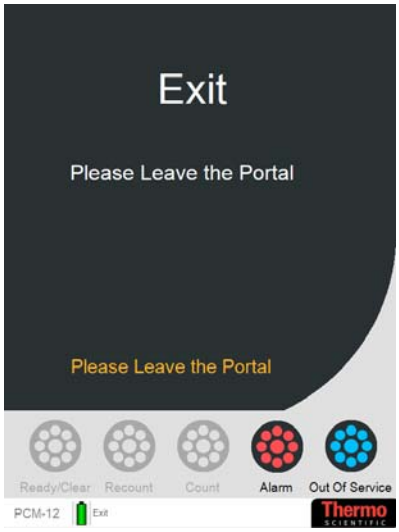
Changes to the Normal Background Monitoring

If a change in the Normal Background Monitoring is detected or the instrument does not have a valid background, iPCM12 will acquire a new background and the "Updating Background" message is displayed.



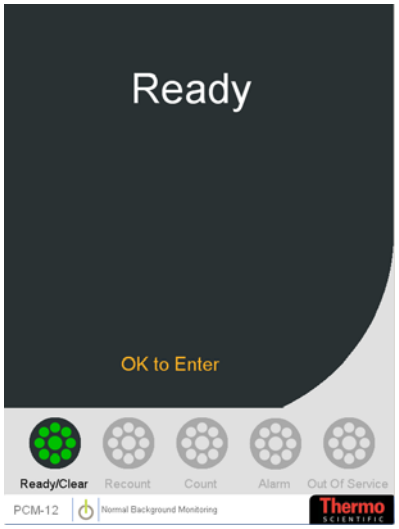
See Notes regarding Changing Background (page 5-78) for more information regarding acquiring a background.

If the portal is entered when the iPCM12 is updating the background, background counting stops, the "Warning Portal is busy" message is displayed and an audible alarm will sound. To continue with the process, the portal must be vacated.

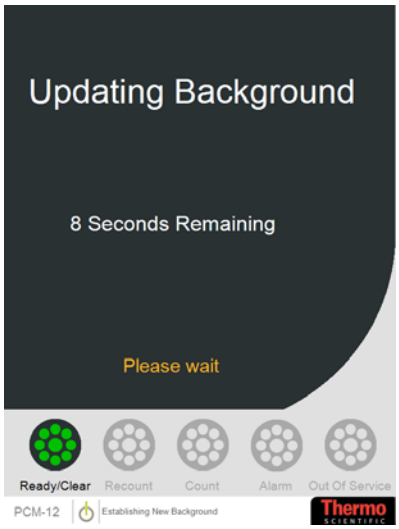


When a new Background has been established, the "Ready – OK to Enter" message is displayed. The iPCM12 is now ready to start monitoring.

See Entering the Portal (page 5-78) for more information.



If more than 15 minutes of continuous operation have elapsed since Normal Background Monitoring has commenced, iPCM12 will acquire a new background and the "Updating Background" message is displayed.



Notes regarding Changing Background

When a changing background has been detected or the instrument does not have a valid background (e.g. at System Startup), the system establishes a new background radiation measurement.

Each 1 second Background count for each detector, is checked against user defined statistical limits for variance from the stored average for that channel. If the count is acceptable it is incorporated into the stored average, otherwise the stored average for all channels is discarded, the blue Alarm lamp will light and "Updating Background - Please Wait" message is displayed while a fresh 100 second Background is accumulated - see Background Update (page 6-12) for more information.

Note: If Quick Background is selected, the length of time taken to acquire a new background will be much shortened (see Operation (page 5-10)).

Personnel Monitoring

Entering the Portal

The iPCM12 can be configured with the following options to control how personnel use the portal (see Operation (page 5-10) for further information):

- Is a User ID Required (see User ID (page 5-79))
- Is a camera installed to take a picture of the user? (see Cameras (page 5-50))
- Complete Both Steps (see Positioning (page 5-81))

User ID

The iPCM12 may be fitted with an external device on either or both sides of the portal to provide identification of the user. This device may include, but not be limited to one of the following device types:

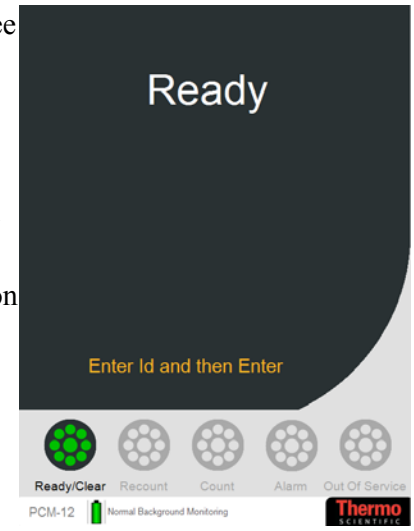
- Barcode scanner
- Magnetic swipe card reader
- RFID reader
- Electronic Dosimeter reader
- Keypad

Note that when a device is fitted, the user must enter the portal from the same side as the reader.

If User ID Required is ticked (see Operation (page 5-10)), the user is requested to enter their ID before entering the portal.

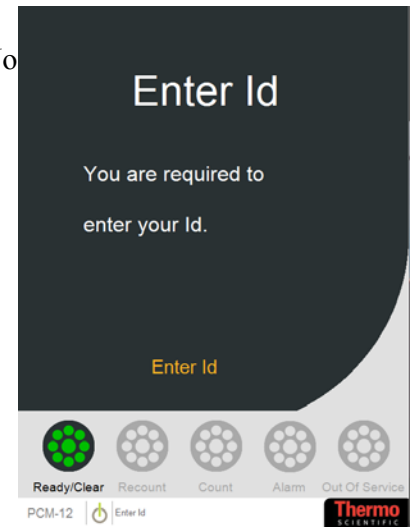
See Voice Prompts (page 5-69) for information regarding verbal instructions.

The user scans their identification at the barcode reader. The measurement process will not continue until this is successful.



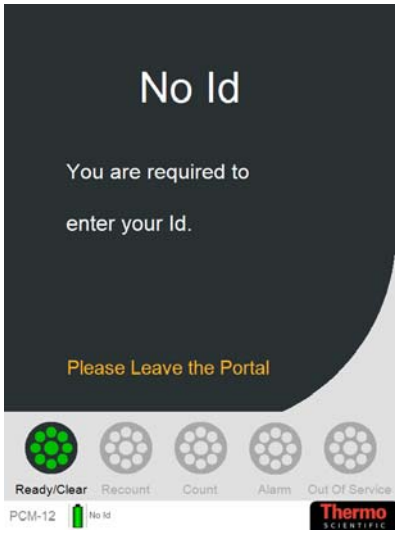
If the user enters the portal without entering their ID, the "No ID" error message is displayed:

See Voice Prompts (page 5-69) for information regarding verbal instructions.



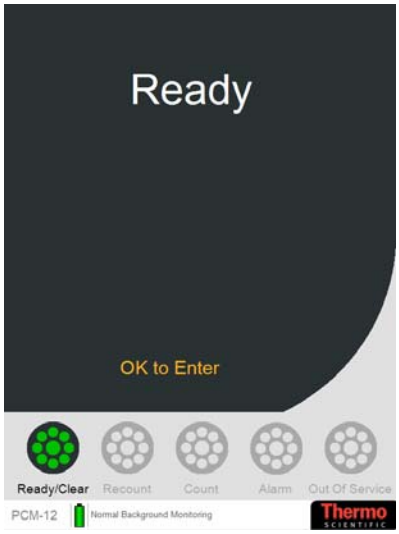
If the User does not enter the portal within the Id Timeout Period (see Operation (page 5-10), the user is asked to leave the portal.

See Voice Prompts (page 5-69) for information regarding verbal instructions.



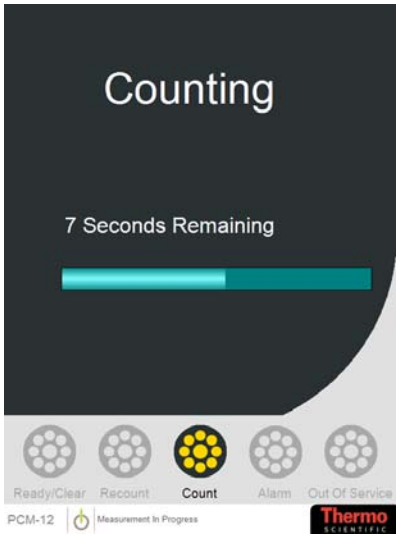
If User ID Required is not ticked, the PM displays the "Ready - OK to Enter" message:

The user enters the portal to commence the measurement process.



When the user steps into the portal and is correctly in position, the count commences.

See Positioning (page 5-81) .



Camera

If Camera(s) is/are installed (see IDS Camera (page 5-49)), a digital picture of the user is automatically taken as they enter the portal, depending on the Camera on Alarm option set in UI Options (page 5-8).

The iPCM12 is able to recognise when the camera is used by detecting which beam has been broken (see Position Sensors (page 5-28)).

Commence Monitoring

The Personnel Monitor can be configured to use a two step measurement, with the user facing the detector array for the first step and then rotating 180 degrees to face away from the measurement array for the second step. See Positioning (page 5-81).

Positioning

If Complete Both Steps is enabled, the user is instructed to position themselves correctly in the Portal. One or a combination of the following messages are displayed depending on whether the sensors are broken (see Position Sensors (page 5-28):

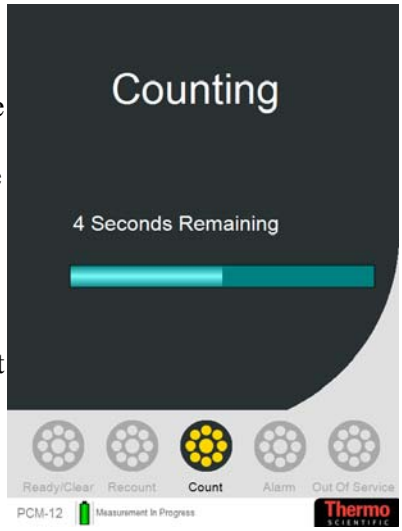
- Face In, Head turned Left
- Insert Left Foot
- Insert Right Foot
- Insert Right Hand
- Move Right Hip Closer

See Voice Prompts (page 5-69) for information regarding verbal instructions.

When the user is in the correct position, measurement starts:

Once monitoring commences, the iPCM12 displays the "Counting" message with an indication of the measurement time remaining.

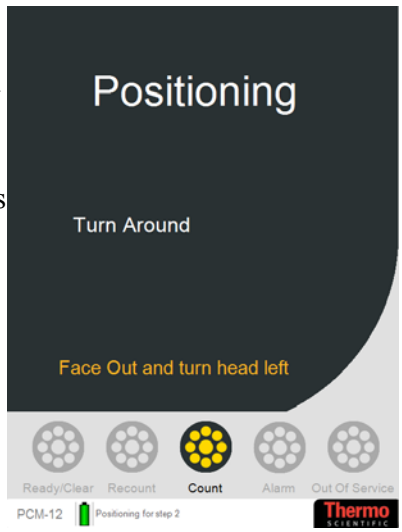
If Complete all Steps (see Operation (page 5-10)) is not ticked and contamination is detected, the result is displayed at this stage and the measurement process is terminated (see ALARM Result (page 5-89).



If the front measurement is satisfactory, then the user is instructed to turn around. One or a combination of the following messages are displayed depending on whether the sensors are broken (see Position Sensors (page 5-28):

- Face In, Head turned Left
- Insert Right Foot
- Insert Left Foot
- Insert Left Hand
- Move Left Hip Closer

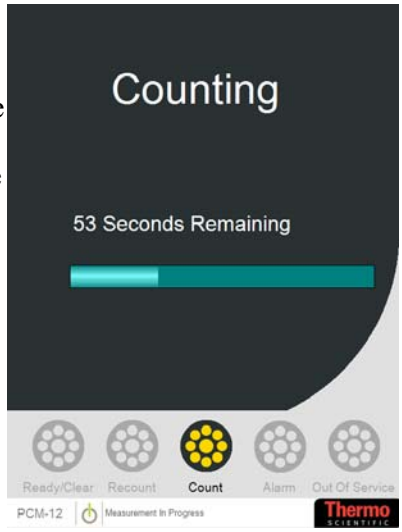
See Voice Prompts (page 5-69) for information regarding verbal instructions.



When the user is in the correct position, measurement continues:

Once monitoring commences, the iPCM12 displays the "Counting" message with an indication of the measurement time remaining.

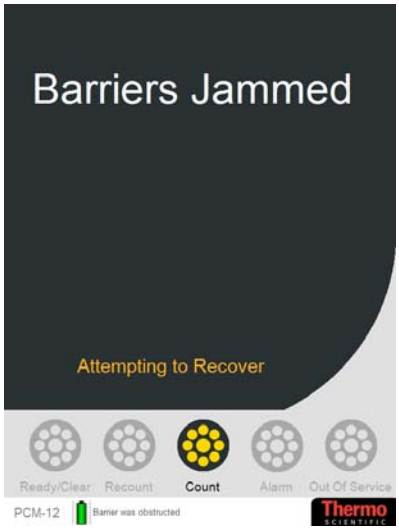
On completion, the result is displayed. See Monitoring Result (page 5-87).



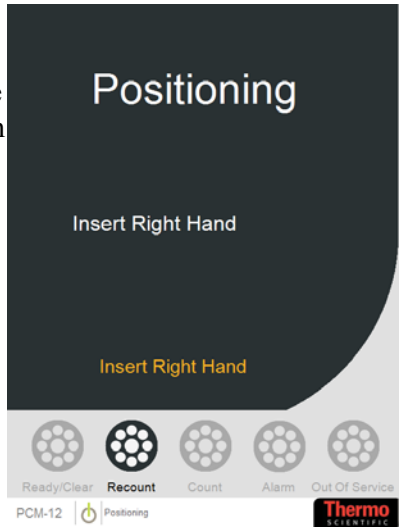
Violations during Monitoring

If a user exits the portal or moves out of position (determined by the optical position sensors) before the measurement is complete, the instrument will sound an alarm and illuminate the recount lamps. If the user re-enters the portal or repositions themselves correctly then the measurement will be resumed. If the user has exited the portal and does not return to the correct position within a configurable timeout, then the measurement is abandoned and the instrument will return to background monitoring.

If the Barriers become stuck during the measurement, the "Barriers Jammed" message is displayed. If this is recoverable, the measurement will continue. If not, the unit becomes Out of Service (see Barrier Error (page 5-98)).



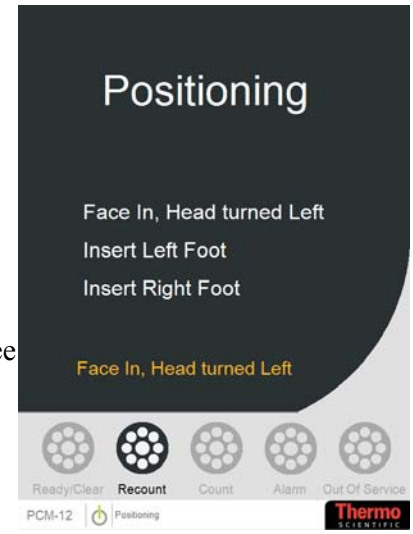
If during measurement, the user moves from the specified position, a "Positioning" message is displayed asking them to return to position.



If the user re-positions themselves in the portal and Restart Measurement on Sensor Break (see Operation (page 5-10)) is ticked, the measurement will be restarted. If Restart Measurement on Sensor Break is not ticked, the measurement will resume. If the user does not return to the correct position within the Exit Barrier Delay (see Operation (page 5-10)), the "Measurement Abandoned" message is sounded.

See Voice Prompts (page 5-69) for information regarding verbal instructions.

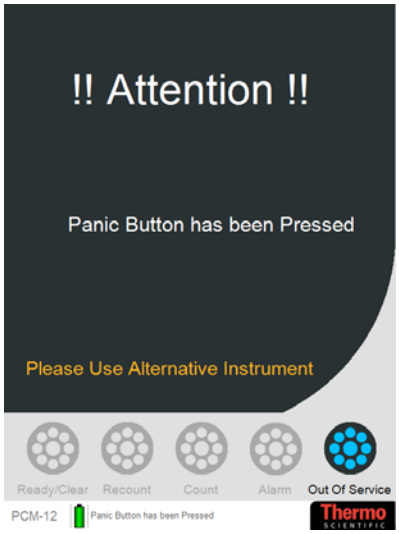
If during measurement, the user exits the portal before the measurement is complete, the "Positioning" message is displayed.



If the user re-enters the portal, then the measurement will be resumed. If the user does not return to the correct position within the Exit Barrier Delay (see Operation (page 5-10)), the "Measurement Abandoned" message is sounded.

See Voice Prompts (page 5-69) for information regarding verbal instructions.

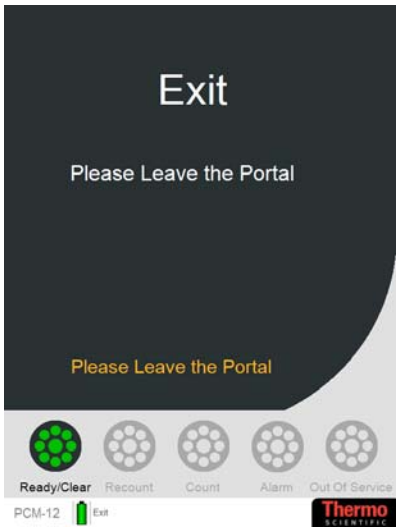
If the user presses the panic button during the measurement, the Panic Button Pressed message will be displayed and the instrument will be disabled. Intervention by an Administrator is necessary to clear the message.



Following an abandonment, if the RCC after Abandoned Measurement option is ticked (see Operation (page 5-10)), the Residual Contamination Count is performed (see Residual Contamination Check (page 5-93)).

If the user does not fully exit the portal on completion of measurement, the "Exit" message is displayed:

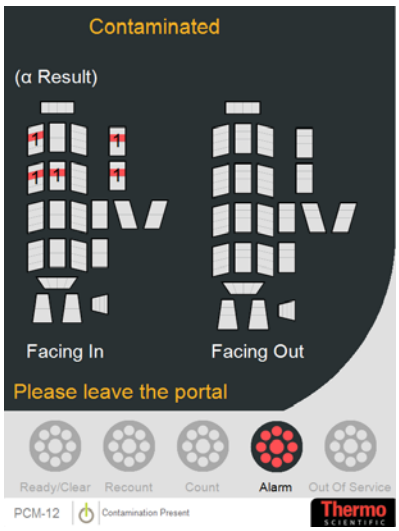
See Voice Prompts (page 5-69) for information regarding verbal instructions.



Background Change during Measurement

If a change in background is detected during a measurement, the user is instructed to exit the portal:

A new background check is required before monitoring can resume. See Changes to the Normal Background Monitoring (page 5-76).



Monitoring Result

An example of the result screen is displayed below:

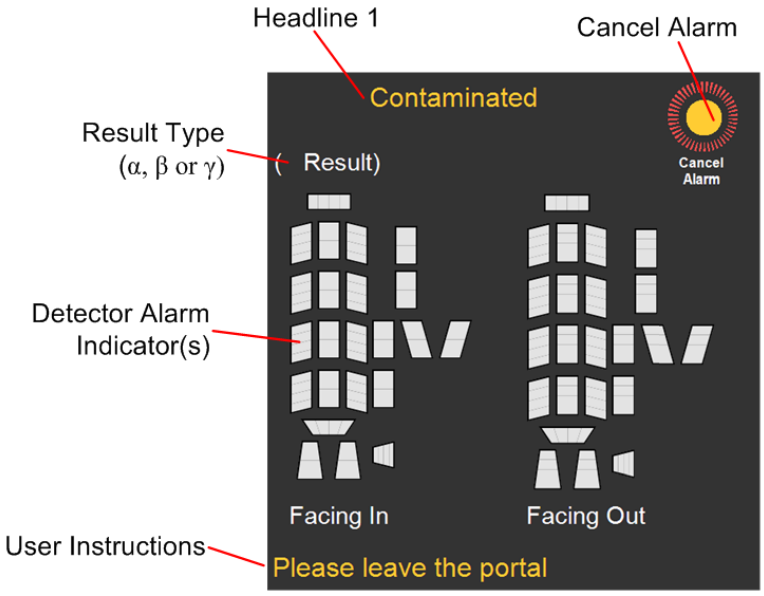


Figure 3 Example of Result display on the iPCM User Screen

The iPCM12 result screen displays the following:

- Headline 1 displaying the type of Alarm

  Note that some of these messages are user-definable - see Messages (page 5-24)

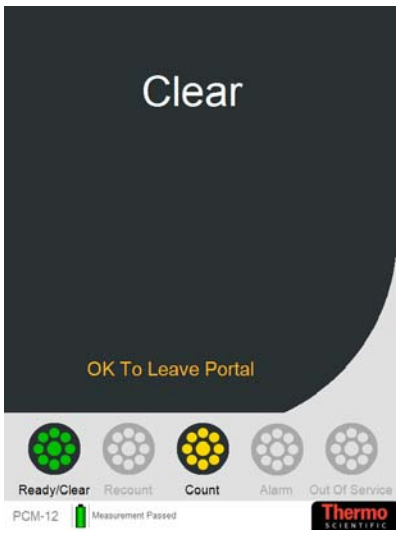
- Cancel Alarm, for more information regarding user acknowledgement of alarm, see Cancel Alarm (page 5-93).
- Result Type
- Detector Alarm Indicator, (see Detector Indicator (page 5-68))
- User Instructions

  Note that some of these messages are user-definable (see Messages (page 5-24)).

For more information regarding the options available to display results, see UI Options (page 5-8) and Operation (page 5-10).

CLEAR Result

If the measured contamination is below the alarm level or when Quick Scan indicates real-clean, the user is informed audibly and visually of the result, with instructions to exit the portal. The "Clear" message is displayed.



See Voice Prompts (page 5-69) for information regarding verbal instructions.

Note that this message is user-definable. See Messages (page 5-24) for more information.

At the end of the measurement sequence, the stored total background count is subtracted from the total measured count to give the net count which is compared with the effective alarm level.

CAUTION: THE iPCM12 CANNOT DISTINGUISH BETWEEN A GRADUAL BUILD-UP OF CONTAMINATION AND SMALL BACKGROUND CHANGES. THEREFORE, IT IS STRONGLY RECOMMENDED THAT A REGULAR FRISKING PROCEDURE IS ADOPTED AND/OR AN INSPECTION OF THE BACKGROUND REPORT SHOULD INDICATE A BUILD-UP OF ACTIVITY – SEE Reports (PAGE 5-50).

Notes regarding Monitoring

Measurement Cycle

During the measurement, a display of the measurement time remaining will be displayed on screen (see Personnel Monitoring (page 5-78) and on the Guidance System (page 5-69).

QuickScan

It is possible to determine quickly during a measurement that the sample id either clean or contaminated if the count rate is sufficiently low or high. This is known as QuickScan. This feature is enabled separately for beta and gamma (it is not applicable to alpha) – see Operation (page 5-10).

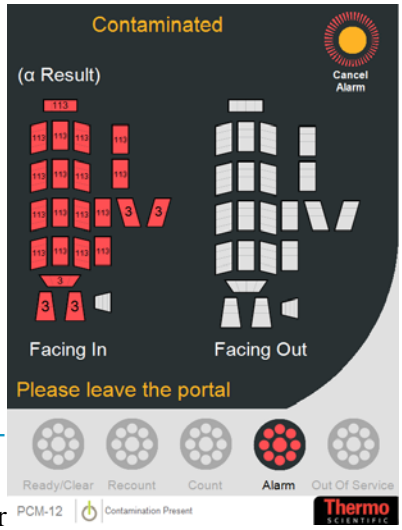
Recount Required

If the user moves out of position during the measurement cycle, the count is halted and the user is prompted to move back into position. The following Recount Required message is displayed. If the user moves back into position, then the count is resumed. If the user leaves the portal, then the measurement is abandoned.

ALARM Result

See Alarms (page 5-18) and Alarm Display (page 5-91) for further information regarding the Alarm displays.

If the measurement is partially complete and the α Low Background Limit is exceeded or when Quick Scan indicates real-dirty, the "Contaminated" message display indicating that contamination is present.

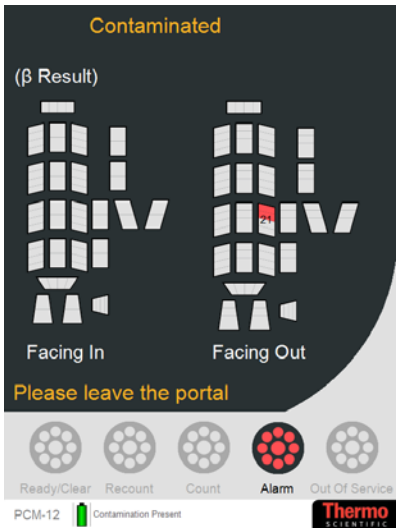


See Voice Prompts (page 5-69) for information regarding verbal instructions.

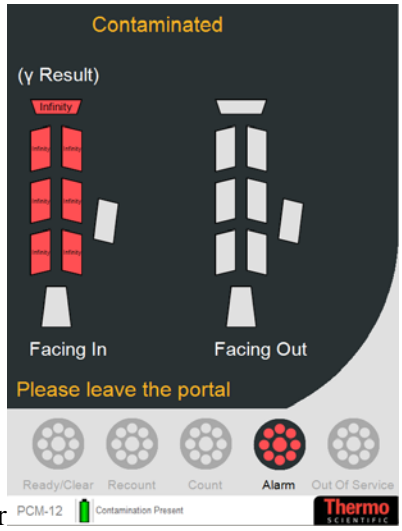
Note that this message is user-definable. See Messages (page 5-24) *for more information.*

See Cancel Alarm (page 5-93) for more information on clearing the alarms.

If the measurement is complete and the β Low Background Limit is exceeded or when Quick Scan indicates real-dirty, the "Contaminated" message display indicating that contamination is present.



If the measurement completes and the γ Low Background Limit is exceeded or when Quick Scan indicates real-dirty, the "Contaminated" message will display indicating that contamination is present.

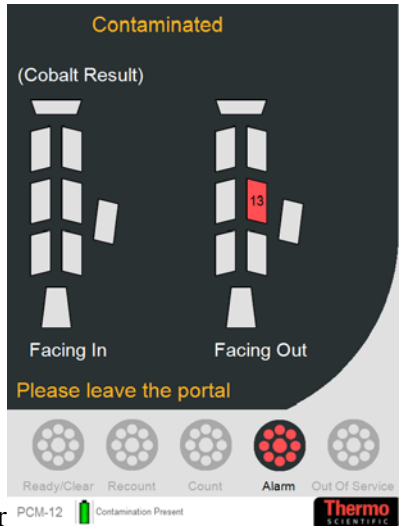


See Voice Prompts (page 5-69) for information regarding verbal instructions.

Note that this message is user-definable. See Messages (page 5-24) for more information.

See Cancel Alarm (page 5-93) for more information on clearing the alarms.

If the measurement completes and the ^{60}Co Low Background Limit is exceeded or when Quick Scan indicates real-dirty, the "Contaminated" message will display indicating that contamination is present.



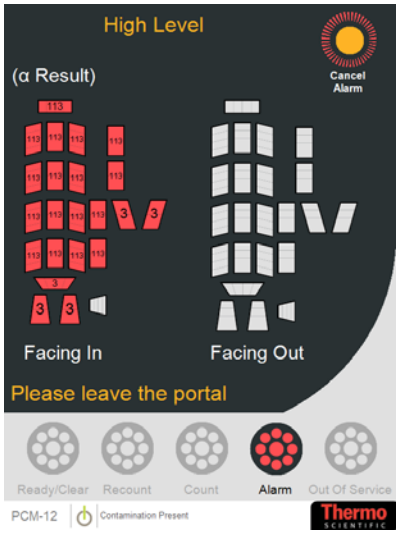
See Voice Prompts (page 5-69) for information regarding verbal instructions.

Note that this message is user-definable. See Messages (page 5-24) for more information.

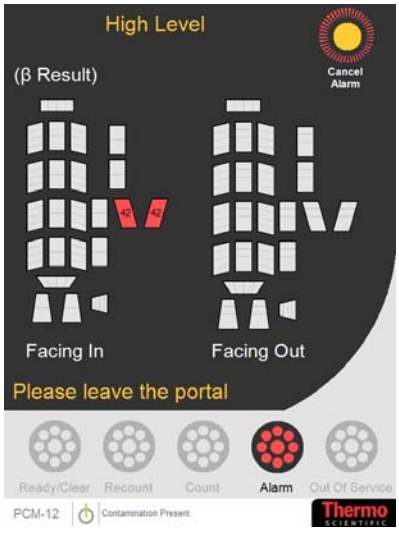
See Cancel Alarm (page 5-93) for more information on clearing the alarms.

Alarm Display

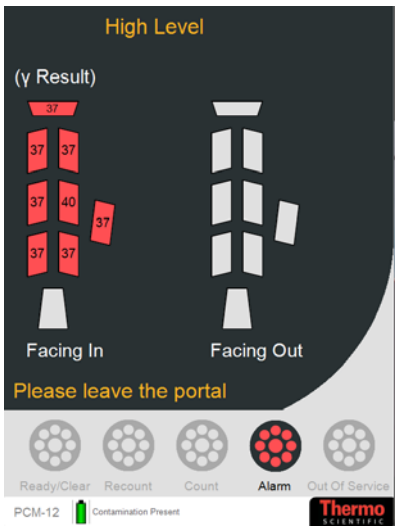
If the α High Alarm is triggered, the information is displayed as follows:



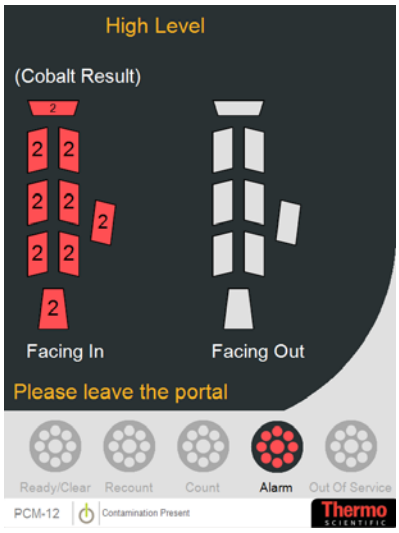
If the β High Alarm is triggered, the information is displayed as follows:



If the γ High Alarm is triggered, the information is displayed as follows:



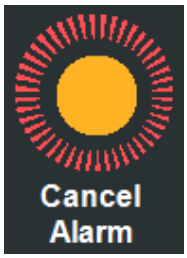
If the ^{60}Co High Alarm is triggered, the information is displayed as follows:



Cancel Alarm

For more information about setting of Alarm configurations, see Alarms (page 5-18).

When an Alarm displays/sounds, it can be cleared in the following instances:



1. The alarm will automatically timeout after the Alarm Duration After Exit setting.

2. If User Can Cancel Alarm Sound is ticked, the User can acknowledge the alarm prior to the Alarm During After Exit timeout.

3. If Failure Display requires Supervisor Acknowledge is ticked, the alarm will display/sound until the Supervisor acknowledges the alarm (note that the Alarm Duration After Exit timeout is ignored in this case).

Residual Contamination Check

Following an alarm, if the Residual Contamination Check after Alarm option is ticked (see Operation (page 5-10)), the Residual Contamination Count is performed.

See Notes regarding Residual Contamination Check (page 5-94) for more information.

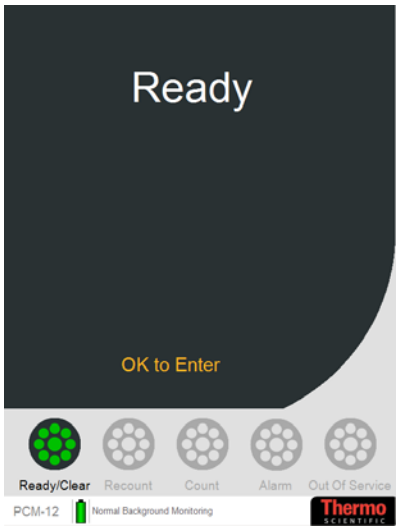
Notes regarding Residual Contamination Check

The Residual Contamination Check is run under the following circumstances:

- If the Residual Contamination Check after Abandoned Measurement option is set - see Operation (page 5-10).

- If Residual Contamination Check after Alarm option is set - see Operation (page 5-10).

The Residual Contamination Check will verify that the current background count rate does not exceed the Background Count Rate before the alarm, by a statistically significant amount. If no contamination is found, the "Ready – OK to Enter" message is displayed and the iPCM12 reverts to Background mode.



However, if residual contamination is detected or the count rate from any detector exceeds 95% of the Amplifier "dead-time", then an Instrument Contaminated state exists. The "INSTRUMENT CONTAMINATED – DO NOT USE" message is displayed (see Instrument Contaminated (page 5-95) for more information).

If the portal is entered during the Residual Contamination Check, the "WARNING – Preparing for Contamination Check" message is displayed.

See Voice Prompts (page 5-69) for information regarding verbal instructions.

Once the Portal is exited, the Residual Contamination Count recommences.

Instrument Contaminated

If the Instrument is contaminated, it is not possible to use the portal and background monitoring is suspended. Intervention by an Administrator is necessary to clear the contamination.

See Actions (page 5-62) for more information regarding clearing the Contamination

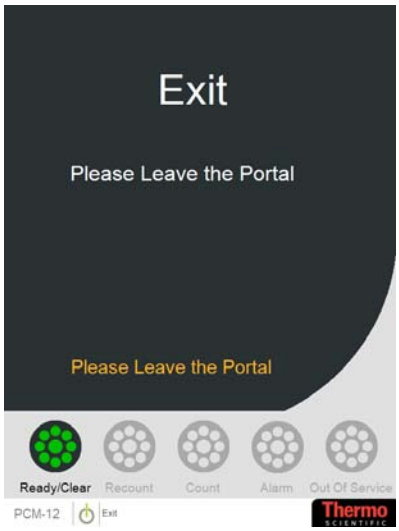
Once the contamination has been cleared, and User Mode is re-instated, the iPCM12 performs the System Self Testing – see Start Up Checks (page 5-71).

Exiting the Portal

The iPCM12 is available with the following options to control how personnel exit the portal:

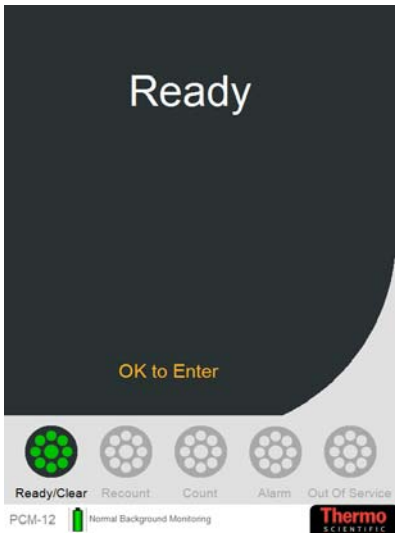
- Alarm Duration After Exit (see Operation (page 5-10))
- Enable Rear Barrier (see Detection Options (page 5-16))

After a result is displayed, the user must exit the portal.



After an ALARM result, the alarm will sound for the length of time set in Alarm Duration after Exit (see UI Options (page 5-8)).

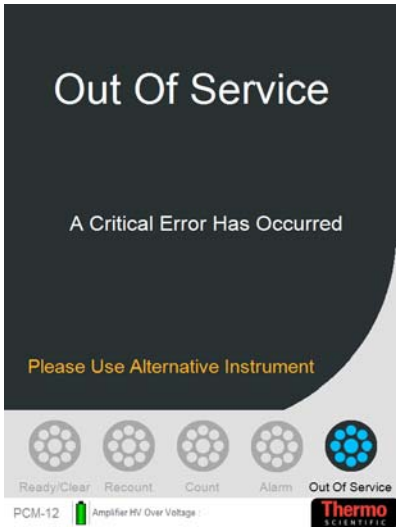
Once the user has successfully vacated the portal, the "Ready" message is displayed:



Out Of Service

Non-recoverable

If the Switch On tests fail or a failure is detected during normal operation, the "Out of Service – Critical Error" message is displayed (note that the reason for the error may be displayed in the message bar at the bottom of the screen).



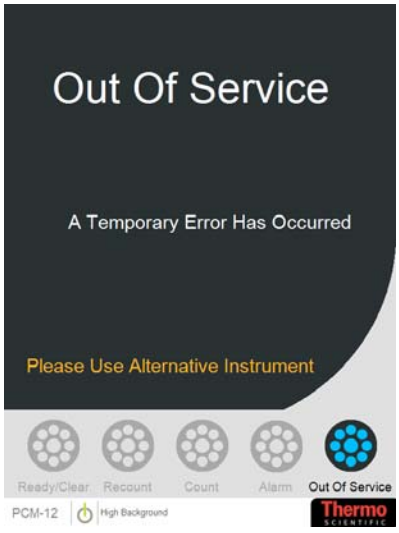
See Voice Prompts (page 5-69) for information regarding verbal instructions.

To clear this error, the state must be cleared in the Administration Mode (or will clear automatically when the Out of Service Recovery Interval is passed, see Operation (page 5-10) for more information).

See Actions (page 5-62) for more information regarding clearing the Critical Error.

Temporary Error

If a High Background event (see Notes regarding High Background (page 5-99) or Low Background Count Rate (see Notes regarding Low Background (page 5-99)) is detected, the "Out of Service – Background Error". During this state, normal background monitoring will continue.



If the fault clears without intervention, the instrument will resume normal operation.

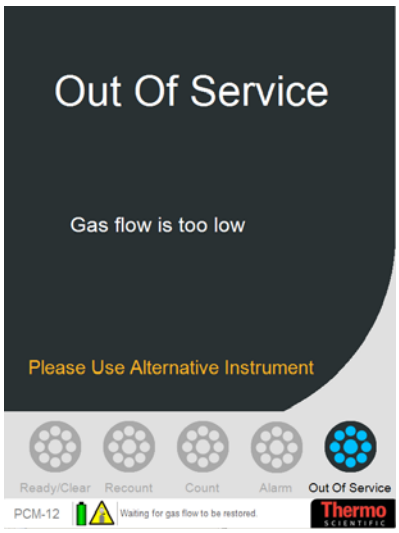
See Voice Prompts (page 5-69) for information regarding verbal instructions.

Gas Flow

If a Low or High Gas Flow is detected, (see Gas Flow (page 5-21), the "Out of Service – Gas flow is too low/high".

If the fault clears without intervention, the instrument will resume normal operation.

See Voice Prompts (page 5-69) for information regarding verbal instructions.

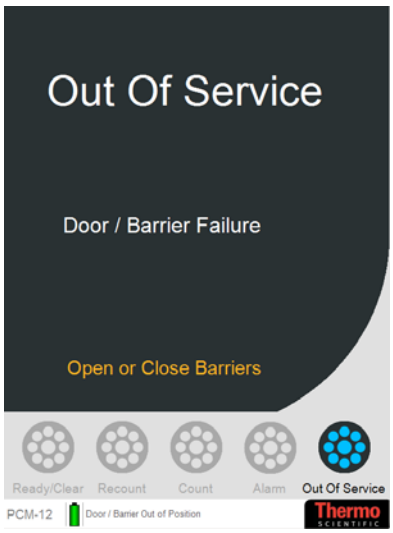


Barrier Error

If a the iPCM detects an error with the Door / Barrier, the "Out of Service – Door / Barrier Failure" error message is displayed. During this state, normal background monitoring will continue.

If the fault clears without intervention, the instrument will resume normal operation.

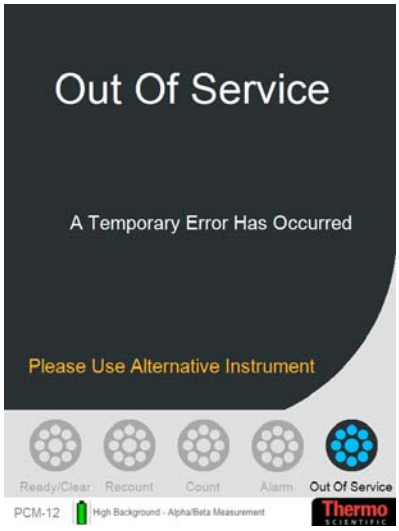
See Voice Prompts (page 5-69) for information regarding verbal instructions.



Notes regarding High Background

The "Out Of Service – High Background" message is displayed if High Background conditions exist.

See Voice Prompts (page 5-69) for information regarding verbal instructions.



As each new set of background count is processed, the monitoring time will be determined. If the calculated sample monitoring time exceeds the user specified Maximum Monitoring Time (see Monitoring (page 5-12)), a high background condition exists and further measurements are not possible. The instrument will enter the "Out of Service" state, with indication of the reason for being out of server e.g. "High Background Conditions".

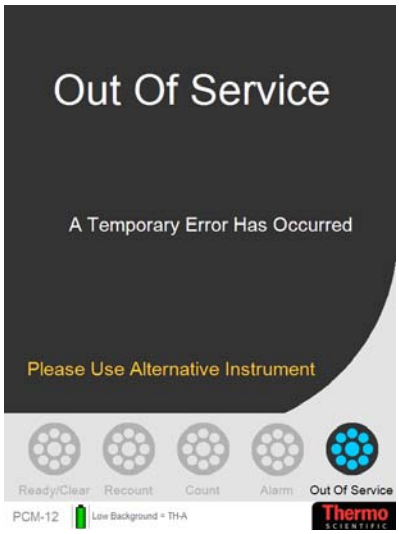
Background measurements will continue as described until the background count rate drops to a level where the calculated monitoring time is acceptable.

It is also possible to exit the high background condition if an administrator increased the Maximum Monitoring Time or decreases the Measurement Certainty.

Notes regarding Low Background

The "Out Of Service – Temporary Error has Occurred" is displayed if Low Background conditions exist.

See Voice Prompts (page 5-69) for information regarding verbal instructions.



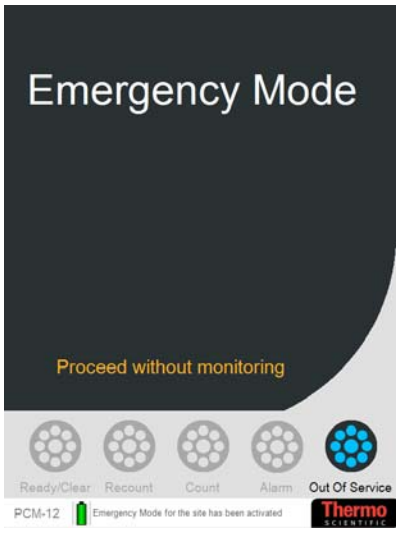
If the count rate falls below the Low Background Limit (see Monitoring (page 5-12)), the "Out of Service – Low Background Counts Detector" message is displayed.

For alpha and beta counts, this is evaluated over the 10 second accumulated background. For gamma counts, this is evaluated for each 1 second background count.

It will remain in this state until the background count rate once again exceeds the threshold on all detectors.

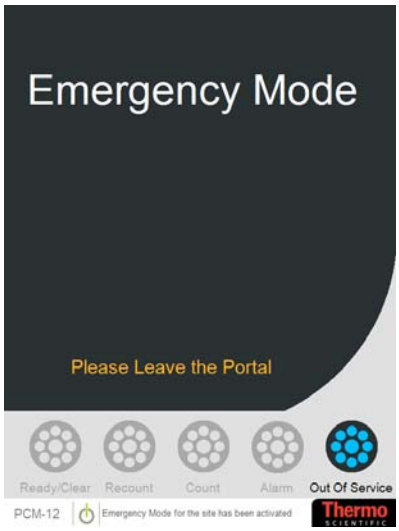
Emergency Mode

"Emergency Mode" is displayed if the system is put into Emergency Mode.



If the portal is entered during the Emergency Mode, the "Please leave the Portal" message is displayed.

See Voice Prompts (page 5-69) for information regarding verbal instructions.



Battery/Mains Supply Indicator

On the main screen, an icon is displayed on the bottom edge of the screen which indicates whether the iPCM12 is running on battery or mains supply as follows:

Indicates that the iPCM12 is running on battery.

See Battery (page 5-31) for more information regarding Battery Status including remaining battery life.

This icon indicates that the iPCM12 is running on mains supply.

Switch Off

Only an Administrator is able to exit the iPCM12 application – see Actions (page 5-62).

Chapter 6 Technical Description - Physics

Performance Characteristics

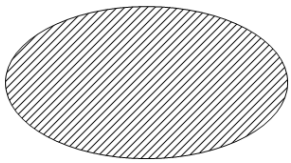
Introduction

The iPCM12 utilises 21 identical large gas flow detectors, with optional 3 further detectors. There are 12 detectors in a body array, which has a sculpted design for best fit around the body. In addition, there are a side of head, shoulder, two hand and two foot detectors. An optional side of foot, top of head and spare purged detector are also available.

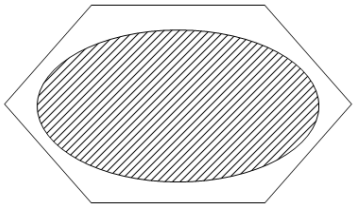
The instrument is designed to measure alpha, beta and gamma contamination on the body, hands and feet of an operator. Since an operator's hands and feet are in direct contact with the respective hand and foot detectors, performance characteristics for the monitoring, contamination on the extremities is directly related to the efficiency figures given in Specification (page 3-1) for hands and feet for the alpha/beta detectors.

This Section is then primarily concerned with the performance characteristics of detecting contamination on the body (legs, torso and head).

In order to obtain high efficiency from low energy betas and to obtain a good all round spatial response, the operator must be close to the detectors. The body Sensor ensures this by forcing the operator to interrupt a photo beam with his torso to initiate monitoring. To obtain good spatial response the detectors must 'fit' the operator. The general shape of the body is:

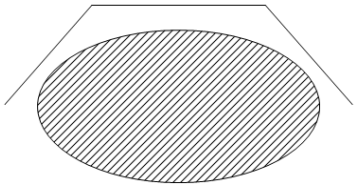


This requires a detection layout of six vertical arrays:



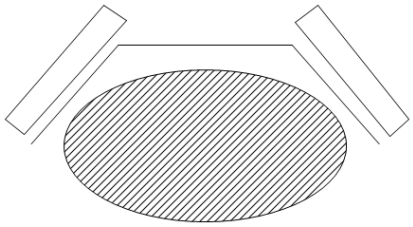
By having three pseudo-vertical arrays and a half-full-height leg array, and instructing the operator to turn round, the six vertical array system is achieved around the upper half of the

body, and eight vertical arrays surround the lower half of the body. The size of the operator has little effect on sensitivity:



In the case of alpha monitoring, the range of alpha particles in air is only a few centimetres (dependent on alpha energy) and so many parts of the body will not be sufficiently close that contamination can be detected. However, alpha monitoring may be thought worthwhile for those parts of the body and legs in near contact with the detectors. The form of detector layout again provides the best arrangement for the detection of alpha contamination with a static system.

In the case of gamma monitoring, although good counting geometry is required, closeness of the body to avoid air absorption is not required, so detector arrays behind the beta detectors give very uniform response.



The iPCM12 combines the results from adjacent detectors to provide sum zones which monitor for distributed contamination over more than one detection area. This leads to an excellent overall spatial response on all regions of the body.

Spatial Response

Great difficulty is experienced in determining the actual performance of the equipment for the monitoring of personnel, because of variation of height and shape of the users. The standard IEC 61098 "Installed personnel surface contamination monitoring assemblies for alpha and beta" emitters published by the International Electrotechnical Committee overcome these problems by providing a standard technique for combining results from a vertical efficiency scan and horizontal efficiency scan around an elliptical phantom, to provide an overall efficiency. Using this technique a comparative assessment can be made.

Vertical Scans

Figures 4 and 5 show the variation of response for a point Beta source placed at 5cm from the centre of the middle detector and moved in a vertical plane. The figures refer to Co-60 and Cl-36 respectively. Figures 6 and 7 illustrate the vertical response to Co-60 and Cs-137 gamma emissions respectively.

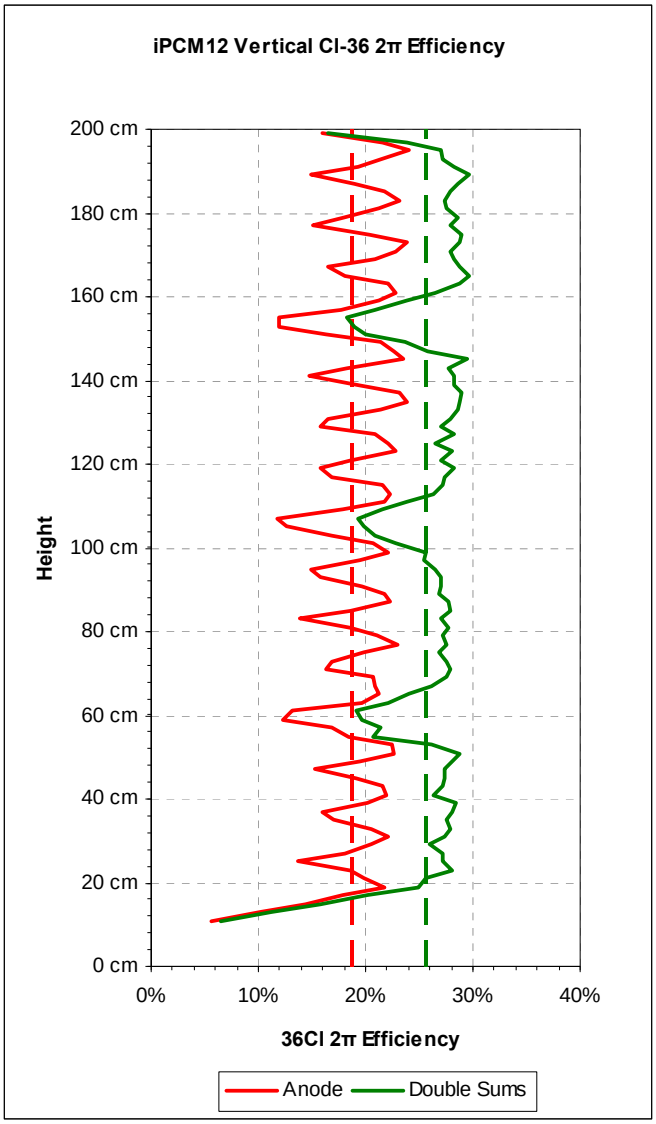


Figure 4 ^{36}Cl Beta – Vertical Scan – Rugged Grille

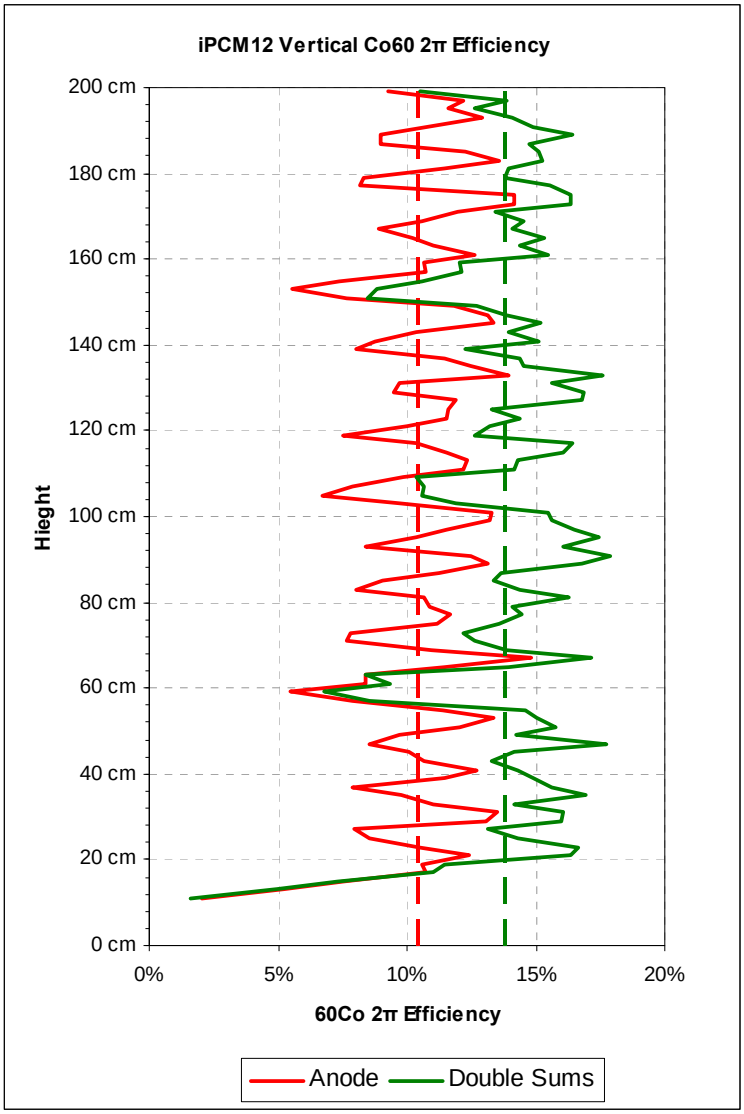


Figure 5 ^{60}Co Beta – Vertical Scan – Rugged Grille

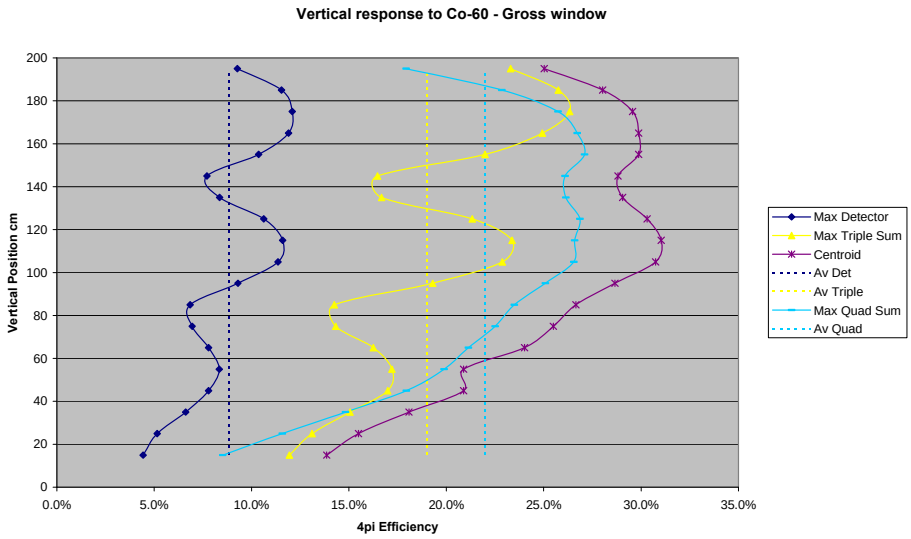


Figure 6 ^{60}Co Gamma – Vertical Scan – Rugged Grille

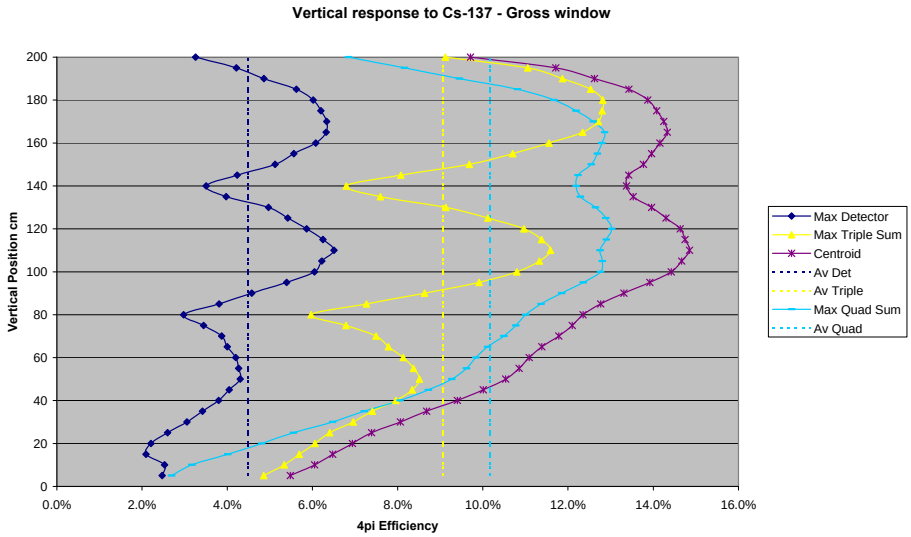


Figure 7 ^{137}Cs Gamma – Vertical Scan – Rugged Grille

Horizontal Scans

Figures 8 and 9 show the variation of response for a point beta source placed at 5 cm from the closest detector and moved in a horizontal plane around the phantom. The figures refer to Co-60 and Cs-137 respectively. These response curves are for a source on the lower half of the body at the height of maximum efficiency in the vertical plane. Figures 10 and 11 illustrate the horizontal response to gamma emissions from Co-60 and Cs-137 respectively at a height of 110 cm.

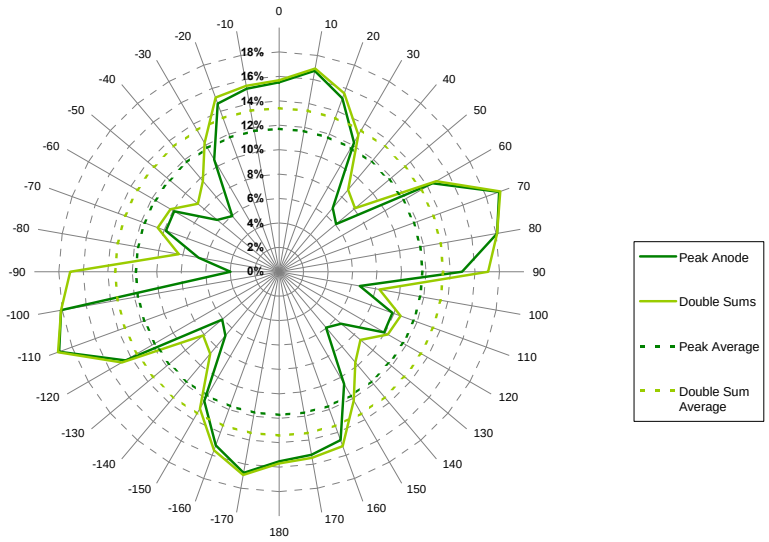


Figure 8 ^{36}Cl Beta – Horizontal Scan – Rugged Grille

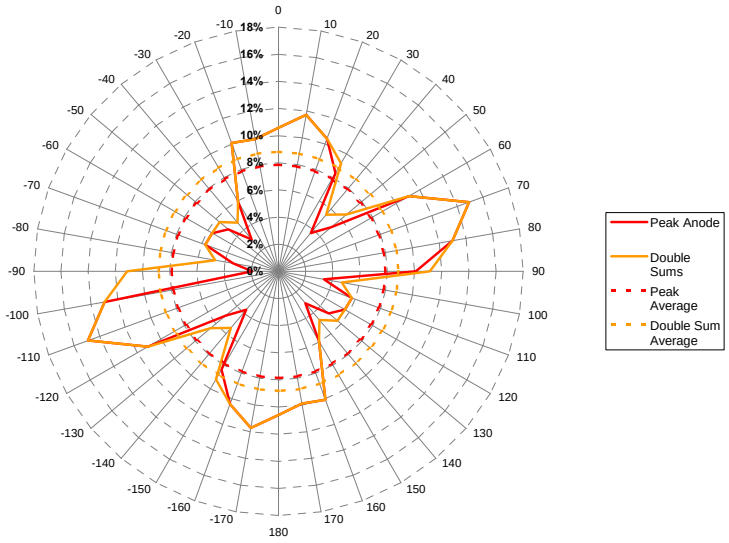


Figure 9 ^{60}Co Beta – Horizontal Scan – Rugged Grille

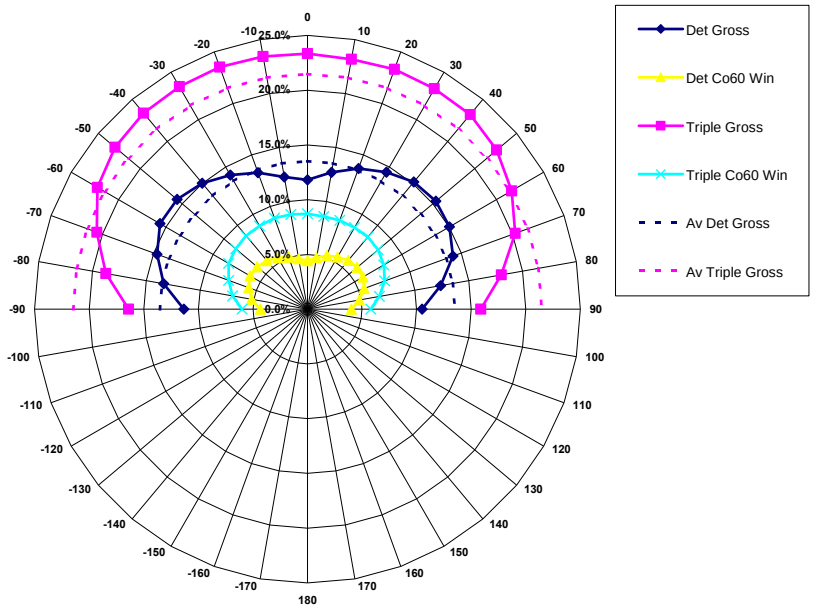


Figure 10 ^{60}Co Gamma – Horizontal Scan

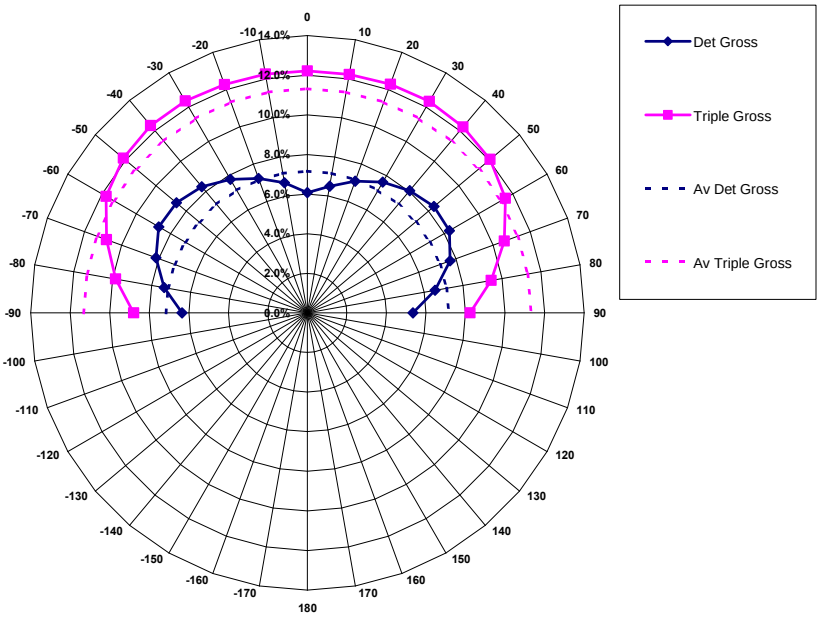


Figure 11 ^{137}Cs Gamma – Horizontal Scan

Body Efficiencies

Following the procedures identified in IEC 61098, the overall Beta efficiency to activity in the body region is evaluated by combining (1) the mean to peak ratio of the vertical scan (Figures 4 to 7) and (2) the mean polar response obtained from the horizontal scans (Figures 8 to 11).

Body Average Efficiency (BAE) is expressed in terms of activity (4π) and given by:

BAE = Mean / Peak vertical Ratio × mean Horizontal polar efficiency.

The BAE for key radionuclides is shown in Gas Flow Detector, Standard Grille, Beta BodyAverage Efficiency (Typical 4π) (page 3-6).

A full type test report is available from Thermo Fisher Scientific on request.

Summing

As can be seen from all Figures 4 to 11, there are areas of low efficiency, these are at the interface between two anode zones for the beta detectors (for beta) and detectors (for gamma). Therefore, if we add the efficiency of two adjacent zones together we achieve a much better efficiency. This improvement in efficiency is however off-set by the fact that with two zones/detectors, the background count-rate is doubled. Since the performance in terms of minimum detectable activity is proportional to the square root of the background, summing of the efficiency of adjacent counters is only advantageous if the sum is $\sqrt{2}$ greater than either of the individual efficiencies.

Similarly for gamma detectors, summing the results of four detectors meeting at a point has only advantages if the scan is twice that due to any individual counter or $\sqrt{2}$ times the sum of two adjacent counters.

Radon Rejection

"Nuisance" Alarms can occur due to naturally occurring Radon gas. Radon gas from the ground and concrete constructions tends to be statically attracted to hair and clothing, particularly in dry and poorly ventilated areas. The primary alpha and beta "daughter" emissions are readily detected by gas-flow counters in close proximity to the body.

Radon alpha decay typically has two associated beta daughter emissions within approx. 62 µs of each alpha emission.

This beta/alpha ratio of 2:1 is only approximate since the precise nature of radon changes with its age, area of origin and climatic conditions throughout the course of the day.

Alarms detected with a Beta/alpha radio of approximately 2:1 can therefore be associated with nuisance Radon. In addition, if the system identifies the timing between the alpha and beta events, filtering should be possible to remove Radon/Thoron events.

In practice, site specific Beta/alpha Radon ratios are determined and a minimum/maximum ratio may be set as a parameter within the application.

"Genuine" Alarms take precedence over possible Radon alarms. Alarms within the defined ratio range area deemed

possible nuisance alarms, triggering an “ALARM – possibly due to Radon” message to the user.

Usually re-monitoring after 15-20 minutes will allow any Radon to decay and a clear result to be obtained.

Explanation of the Operational Calculations

Introduction

It is a requirement to measure personnel contamination as quickly and accurately as possible. Optimum detection efficiencies are required, with minimum statistical error in giving alarm indications. Measurement of contamination is dependent on ambient background level. Accuracy of measurement of both background and contamination is dependent on respective background and contamination monitoring times, self absorption and also on chosen probability of false alarm and probabilities of detection.

This section summarises the calculations employed by the system CPU in determining whether the parameters selected by the user allow the monitor to operate correctly. The section then shows the criteria used to determine

Description of Parameters Used in Calculations

The parameters used in the calculations are summarised and abbreviated as follows:

t_B **Background Update Time (seconds)** is the time over which the average background counts have been accumulated. This time is usually fixed at 100s, but when Quick Background is enabled, this time is flexible and may be significantly lower than 100 s. Background measurements can only occur when the portal is not occupied.

B_{sum} **Average Background Count Rate (cps)** is the mean background of the detectors, measured over the background update time (**t_B**). This is a fixed 100 second rolling average in the iPCM12, unless Quick Background is enabled. See Notes regarding Normal Background Monitoring (page 5-76).

B_{eff} **Effective Background while Monitoring (cps)** is the mean background of the detector, B_{sum}, corrected for the effect of attenuation.

T_{cal} **Calculated Monitoring Time (seconds)** is the minimum time required to perform a measurement according to the calculation in Calculation of the Monitoring Time (Tcal) (page 6-14). The specified alarm level must be achieved with the required certainty in the Monitoring Time, which will depend upon a number of user programmable variables, as well as the Background.

T_{mon} **Actual Monitoring Time (seconds)** is the actual time for which users are monitored. The calculated monitoring time (T_{cal}) is first rounded up to the nearest whole second. It is then compared with the user programmed Minimum Monitoring Time (T_{min}) and if $T_{cal} < T_{min}$ then T_{mon} is forced to be T_{min}, otherwise $T_{mon} = T_{cal}$. If $T_{mon} > T_{max}$ then a high background condition exists and normal monitoring is not possible (see Calculation of the Monitoring Time (Tcal) (page 6-14)).

T_{min} **Minimum Monitoring Time (seconds)** is the Minimum Time for which users are monitored, regardless of the calculated Monitoring Time, see explanations of Tcal and Tmon above. The Minimum Monitoring Time is set from in Monitoring (page 5-12)

T_{max} **Maximum Monitoring Time (seconds)** is the maximum time for which users are monitored, regardless of the calculated Monitoring Time, see explanations of T_{cal} and T_{mon} above. The Maximum Monitoring Time is set in Monitoring (page 5-12).

C_{Act} **Contamination Alarm Level (variable unit)** is the activity level at which the user requires the alarm to be triggered. The alarm level is set in Alarms (page 5-18) and the units, e.g. dpm, Bq, nCi, may be selected in UI Options (page 5-8).

C_{cps} **Contamination Alarm Count-rate (cps)** is the count-rate at which the user requires the alarm to be triggered. It is equivalent to the Contamination Alarm Level set by the Administrator modified by the system Efficiency Correction Factor (E).

C_{effect} **Effective Alarm Count rate (cps)** is the effective net count rate at which the iPCM12 normal alarm is triggered. The Contamination Alarm Count rate is modified to take account of the monitoring time, background statistical fluctuation and user programmed Probability of Detection. This ensures the Alarm set point reflects the measurement certainty required. The current Effective Alarm count rate may be viewed in Information (page 5-26). The C_{effect} calculation is detailed in Contamination Alarm (page 6-16).

F **Probability of False Alarm (σ)** is the probability that a false alarm does not occur during a measuring sequence. The value of F in terms of sigma is set in Detection Options (page 5-16), where the associated probability is shown alongside in parenthesis. The value is usually set as high as possible, so that false alarms do not occur, e.g. one false alarm in a hundred measurements is a probability of 99% (2.4σ), see Table 1 Probability - Sigma and % (page 6-21).

P **Probability of Detection (σ)** is the probability that exactly one Alarm Level of contamination will cause an alarm. The value of P in terms of sigma is set in Detection Options (page 5-16), where the associated probability is shown alongside in parenthesis. The minimum allowable probability is 50% (zero sigma). Increasingly higher probabilities become increasingly subject to other parameters, particularly background level. The interrelationship will be discussed in the Calculation stages.

E **Efficiency Correction Factor** is the system efficiency (either sum zone efficiency for multiple detectors, or individual detector contact efficiency) to the nuclide (E_{nuc}) or mixture of nuclides (E_{mix}) being monitored. E is given by the contamination count rate in a given time and divided by the activity. E is determined by calibrating with a known radionuclide source, as detailed in Calibration for Other Nuclides (page 10-3).

A **Attenuation Factor** is an allowance for attenuation of a background field by users being monitored. Values of A can be determined for each detector and body position by following the test procedure in Detectors (page 3-4).

DL **Detection limit** or Minimum Detectable Count Rate (cps)

M_{Act} **Minimum Detectable Activity (variable unit)** is the minimum Activity the system can detect within the calculated monitoring time. It is very dependent on the programmed False Alarm rate and the prevailing background conditions and thus will continuously vary. The current Minimum Detectable Activity (MDA) may be viewed in Information (page 5-26) in the units specified in UI Options (page 5-8). The MDA calculation is detailed in Minimum Detectable Activity (MDA) and High Background Criterion (page 6-15).

R_{Act} **Activity of Contamination (variable unit)**

Background Update

When the instrument is not monitoring a user, it will be monitoring background.

The background is monitored over one second check periods. The one second background counts are accumulated over a 10 second period and averaged to derive the Background Sample countrate (b) for each detector. Each 10 second background sample is screened for Low beta counts, high alpha counts and compared with the stored average for the user defined Changing Background Level. When verified the background sample is accumulated into a Rolling Average Background (B) for each detector. A minimum of ten valid 10 second Background Samples are accumulated for each detector before monitoring is permitted. Valid 10 second Background samples subsequent to the 10th are accumulated into the average and the oldest discarded to maintain a 100 second “Rolling Average” for each detector.

The Average Background is used in conjunction with other system parameters to calculate the Monitoring Time for each channel and hence screen for High Background conditions before monitoring can commence.

As a contaminated user approaching the iPCM12 may affect the background of the instrument, background counts are pre-buffered for 2 seconds before being incorporated into the main background of the instrument. When a user is detected entering the instrument, these pre-buffered background counts are discarded.

To increase the availability of the iPCM12, the background update time (t_B) may be set to be dynamic, by utilizing the Quick Background option (see **Error! Reference source not found.** (page **Error! Bookmark not defined.**)). When a new background count rate needs to be acquired, the instrument will only stay out of service for as long as it takes to acquire a background that results in a count time lower than the Maximum Monitoring Time (T_{max}) set for the instrument. At

this point, the instrument is capable of making measurements that meet the Probability of False Alarm and Detection criteria, albeit with a longer Actual Monitoring Time(T_{mon}) than would be possible with a longer Background Counting Time (t_B). This technique will allow monitoring to re-commence earlier and as more background counts are subsequently acquired, monitoring times will fall.

On the gamma option, because the FHT681 has an upper threshold that is typically configured as a "cosmic threshold", the gross counts are defined as counts in the energy band between the lower and upper thresholds. This is referred to as the gross counts window.

Changing Background

In relatively stable background conditions, 100 second "rolling average" accumulates an accurate background count. It is, however, slow to respond to sudden background disturbance and drift, making it is necessary to screen each count before incorporating it into the rolling average. Consequently to guard against inaccurate measurements and false alarms, the iPCM12 reads and checks the counts from each detector every second. A changing background conditions exists if either of the following conditions are true:-

Any one detector count shows a Mσ change from the stored average for that channel:

$$\left|\left[B_{av} - C_a\right]\right| \geq \mathrm{M}\sqrt{B_{av}}$$

where B_{av} is the rolling average for any one detector.

C_a is the counts registered in the last one second background update.

M is the Detector Changing Background variable (see Monitoring (page 5-12)). The default value for M is 7. It is not recommended that M should be set below 4.0σ.

In addition for the gamma option, all nine detector counts show a Nσ change from their relevant stored averages in the same direction:

$$\left|\left[B_{av} - C_a\right]\right| \geq N\sqrt{B_{av}}$$

where B_{av} is the rolling average for any one detector.

C_a is the counts registered in the last one second background update.

N is the Gross Changing Background variable (see Monitoring (page 5-12)). It is not recommended that N should be set below 3.0σ.

The former expression detects gross changes in any single channel, while the latter guards against significant drift in all channels.

Calculation of the Monitoring Time (T_{cal})

After every successful background update, the average background for each channel is updated. The eight average backgrounds are then summed and a new monitoring time is re-calculated as follows:

$$C_{cps} = C_{Act}.E.Z_{Act}$$

where Act is one of the units below

Z_{Act} is the corresponding multiplier

Units	Unit Multiplier Z_{Act}
Bq	1
kBq	1000
Dpm	0.01666
pCi	0.037
nCi	37
µCi	3.7E4
mCi	3.7E7
Ci	3.7E10

T_{cal} found by solving:

$$C_{cps} = F\sqrt{\frac{B_{eff}}{t_B} + \frac{B_{eff}}{T_{cal}}} + P\sqrt{\frac{B_{eff}}{t_B} + \frac{B_{eff} + C_{cps}}{T_{cal}}} + \frac{1}{4}(F+P)^2\left(\frac{1}{t_B} + \frac{1}{T_{cal}}\right)$$

In practice, the software solves this expression using a numerical substitution for T_{cal} and iterative binary search technique. The value of T_{cal} which provides the solution is then rounded up to the nearest whole second and compared to the user programmed minimum and maximum monitoring times.

The actual monitoring time (T_{mon}) used when monitoring is then set according to the following criteria:

$T_{mon} = T_{cal}$ when $T_{cal} > T_{min}$

$T_{mon} = T_{min}$ when $T_{cal} \leq T_{max}$

If $T_{cal} > T_{max}$ then a high background condition exists and monitoring is not possible. See Notes regarding High Background (page 5-99).

Minimum Detectable Activity (MDA) and High Background Criterion

Once a mean background count rate has been calculated, the iPCM12 will be ready to monitor users, and the Minimum Detectable Count Rate, also referred to as the detection limit (DL) is found by solving the following formula for DL:

Therefore $M_{Act} = \frac{DL}{Z_{Act}.E}$,

$$DL = F\sqrt{\frac{B_{eff}}{t_B} + \frac{B_{eff}}{T_{mon}}} + P\sqrt{\frac{B_{eff}}{t_B} + \frac{B_{eff} + DL}{T_{mon}}} + \frac{1}{4}(F+P)^2\left(\frac{1}{t_B} + \frac{1}{T_{mon}}\right)$$

where *Act* is the activity unit

Detectable Activity and Detection Limit may be viewed on the Information sub-menu (see Information (page 5-26)) and will be displayed in the units selected in UI Options (page 5-8).

NOTE:
MDA may differ from the Alarm level because:
- T_{mon} is rounded up
- T_{min} may take effect

Changing Conditions

Changing conditions applies to beta and gamma measurements only.

During the monitoring cycle, the monitoring time is subdivided into timeslices. Each sum of the count rates on all detectors in a slice is compared to the average count rate in the cycle up to that point.

Changing Conditions exist where the following formula is satisfied:

$$\left|\left[C_{av} - C_{sl}\right]\right| \geq N_{sl}\sqrt{C_{av}}$$

where C_{av} is the rolling average count rate within the monitoring cycle, up to the point of the check.

C_{sl} is the counts registered in the last time slice

N_{sl} is the Changing Conditions variable (see Monitoring (page 5-12)). It is not recommended that N_{sl} should be set below 3.0σ.

The first Changing Conditions check will take place after $2T_{sl}$ and then after every second within the monitoring cycle.

where T_{sl} is the Changing Conditions period (time slice) variable (see Monitoring (page 5-12)).

Contamination Alarm

After monitoring a user for the prescribed monitoring time (T_{mon}), the effective contamination alarm level (C_{effect}) is calculated as follows:

$$C_{effect} = C_{cps} - P\sqrt{\left(B_{eff}\left(\frac{1}{t_B} + \frac{1}{T_{MON}}\right) + \frac{C_{cps}}{T_{MON}}\right)}$$

The total system background count rate B_{eff} is then subtracted from the total system gross contamination count rate (C_{gross}), and the remaining (net) contamination count rate compared with the alarm level. So an alarm condition exists if:

$$\left(C_{gross} - B_{eff}\right) \geq C_{effect}$$

Zone Summation (if required)

The alarm count rate for two zones summed together, is the square root of the sum of the squares of the alarm count rate of the individual zones, i.e. new summed alarm count rate, C_{sum}, is given by

$$C_{sum} = \sqrt{\left(C_{effect,1}\right)^2 + \left(C_{effect,2}\right)^2}$$

Figure 12 shows the alpha beta sum zones.

Calculation of Activity and Associated Uncertainty

The system will display the level of radioactive contamination both on and in the user. The activity is displayed in multiples of the Alarm level, along with the zone that triggered the alarm on the body mimic. The derived activity in the appropriate activity units, and its associated uncertainty, is stored in the instrument database for later review. Only those numerical values that are in excess of the MDA are stored.

The activity is calculated using the following formula:

$$R_{Act} = Z_{Act} . \frac{C_{gross} - B_{eff}}{E_{mix}}$$

where R_{Act} refers to the activity in the selected unit.

le nuclide mix, $E_{mix} = E_{nuc}$. However where the user has created a mix with multiple nuclides:

$$E_{mix} = \sum E_{nuc} . P_{nuc}$$

where E_{nuc} is the efficiency of the system to a specific nuclide

P_{nuc} is the proportion of the specific nuclide within the total mix.

The uncertainty of the activity measurement is calculated as follows:

$$\frac{R_{Act}.N_{conf}}{E_{mix}}\sqrt{\left(\frac{B_{eff}}{t_B}+\frac{C_{gross}}{T_{mon}}\right)}$$

where N_{conf} is the number of confidence levels.

Quickscan

Quickscan applies to beta and gamma measurements only.

Quickscan is a method used to identify, within the monitoring time T_{mon}, whether the user is either "clearly" contaminated or clear, referred to as "real-dirty" or "real-clean". Quickscan is enabled in Detection Options (page 5-16). It is only activated when $T_{mon}>T_{min}$.. It will never be activated if the alpha monitoring time ($T_{mon\alpha}$) is greater than or equal to the beta and/or gamma monitoring time.

The Quickscan period T_Q is the time period after the beginning of the monitoring cycle, at which the first time slice check is undertaken. Subsequently further Quickscan checks will be undertaken at periods that are integer multiples of T_Q e.g. $2T_Q$, $3T_Q$, until the end of the monitoring period. The Quickscan period is set Operation (page 5-10).

If the Quickscan formula (refer to Thermo Fisher Scientific) is satisfied at any of the Quickscan checks, then the monitoring cycle will terminate, with the appropriate clean or contaminated indication.

Quick Background

Quickscan applies to beta and gamma measurements only.

Quick background is a method that evaluates the shortest possible background monitoring time, while still satisfying the statistical criteria. Quick Background is enabled in Operation (page 5-10).

The formula used to evaluate the Calculated Monitoring Time (T_{cal}) is used. The system will re-evaluate the value of T_{cal} after every second of the background update, where the Background Update Time (t_B) is a variable. When the value of $T_{cal} < T_{max}$, then the system will return to service. Since the system acquires background counts at any time it is not in use, then the value of T_{cal} will reduce until a count rate from the previous 100 s has been acquired.

Co-60 Window Monitoring

The Co-60 window only applies to gamma measurements.

A specific alarm for ^{60}Co contamination may be set, if enabled in Alarms (page 5-18). This alarm is based upon monitoring only those high energy photons which cannot be associated with radionuclides that emit lower energy photons, such as ^{137}Cs. Therefore it is also possible for other high energy photon emitters to be monitored using the ^{60}Co window.

The method of assessment of background count rates and contamination level, applies to the ^{60}Co window channel in the same way as for gross alarms described in this section. However both the background count rate B_{Co} and the efficiency E_{Co}, are considerably lower than for the gross sum channel.

Residual Contamination Level

After a measurement resulting in an Alarm condition, a Residual Contamination Count (RCC) may be taken, if enabled in Operation (page 5-10). A count equal to the monitoring time (T_{mon}) is enforced.

Residual Contamination is assumed to exist where the following formula is satisfied:

$$\left(C_{RCC} - B_{sum}\right) \geq N_{RCC}\sqrt{\left(\frac{B_{sum}}{T_{mon}}\right)}$$

where C_{RCC} is the average count rate during the Residual Contamination Count period.

N_{RCC} is the RCC threshold variable (see Monitoring (page 5-12)).

The default setting for N_{RCC} is 7.0σ and should never be set to a less that the sum of the probabilities of detection and false alarm (P+F).

In the event of residual contamination being detected, the iPCM12 will enter an "Out of Service" state and monitoring will not be possible (see Notes regarding Residual Contamination Check (page 5-94)). Intervention by a password holder will be required to terminate the fault status (see Instrument Contaminated (page 5-95)).

Automatic Calculation of Calibration Monitoring Time

The Calibration technique (see Calibration Menu (page 5-33)) uses flash (10 second) background and source counts to automatically calculate the count time for the user. The Calibration Accuracy and the associated confidence level are set in Calibration (page 5-15)).

The count confidence level has a default setting of 3σ (99.7%) which is a generally accepted Confidence level that produces acceptable count times.

Then Calibration Count Time,

where N_{conf} = 3 (Count Confidence Level of 99.7%)

n = Flash source + background Count (cps)

b = Flash Background Count (cps)

A = Calibration Accuracy (ratio e.g. 5% = 0.05)

The calculated count time is rounded up to the nearest whole second and T is limited to 10,000 seconds.

$$T = N_{conf}^2 \frac{\left(n + \sqrt{nb}\right)}{A^2 (n-b)^2} (Sec's)$$

Calculation of Alarm Levels

This section describes the Calculation of alarm levels for Parameter data entry. Alarm levels may be set in terms of activity or count rate (cps).

Assumptions

To calculate the Alarm Levels in terms of count rate, the following assumptions are made:

The surface emission rate of the clothing or body is assumed to be half of the activity. This will only be true for a perfect source with zero backscatter and self absorption. In practice the operator may wish to make allowance for these effects when setting the count rate alarm levels (especially where alpha and low level beta contamination is being monitored).

The following formula is used to Calculate the Alarm Countrate, C, for alpha, Beta and gamma Contamination.

$$C = \tfrac{1}{2} A.a.E_{nuc}$$

where *A* is the alarm Activity per unit area required to give an alarm, typically in UK:

40 Bq/cm^2	(2400 dpm/cm^2)	for	γ
4 Bq/cm^2	(240 dpm/cm^2)	for	B
0.4 Bq/cm^2	(24 dpm/cm^2)	for	α

Note that in USA, a typical beta activity alarm limit is 5000 dpm, averaged over 100 cm^2 i.e. 0.83 Bq/cm^2.

a is the area over which the Contamination activity is averaged normally 300 cm^2 for both sides of the Hand and sole of the foot and 100 cm^2 for Body (including the head).

E_{nuc} is detector efficiency to nuclide of interest.

For Hand and Feet alpha and beta detectors, this is expressed in terms of S.E.R. (2π). Body average efficiencies for Beta and Gamma body detectors are expressed in terms of activity (4π), therefore:

$$C = A.a.E_{nuc}$$

Examples:

^{60}Co Beta on Hands (standard grille)

If $A = 4$ Bq/cm^2

$a = 150cm^2$ (assumed area of one side of one hand)

E_{nuc} = 31% detector efficiency to ^{60}Co (2π)

then $C = ½ \times 4 \times 150 \times 0.31$ = 93 cps

^{241}Am Alpha on Hands (standard grille)

If $A = 0.4$ Bq/cm^2 (2π)

$a = 150cm^2$ (assumed area of one side of one hand)

E_{nuc} = 28 detector efficiency to ^{241}Am (2π)

then $C = ½ \times 0.4 \times 150 \times 0.28$ = 8.4 cps

Alpha and ßeta Feet values are calculated similarly (using a as 300 cm^2).

^{60}Co Beta on Feet

If $A = 4$ Bq/cm^2

$a = 300cm^2$ (assumed area of sole of one foot)

E_{nuc} = 35% Detector Efficiency ^{60}Co (2π)

then $C = ½ \times 4 \times 300 \times 0.30$ = 210 cps

^{241}Am Alpha on Feet

If $A = 0.4$ Bq/cm^2

$a = 300cm^2$ (assumed area of sole of one foot)

E_{nuc} = 32% detector efficiency to ^{241}Am (2π)

then $C = ½ \times 0.4 \times 300 \times 0.32$ = 19 cps

^{60}Co Beta on Body (unsummed) – standard grille – UK limit

If $A = 4$ Bq/cm^2
$a = 100$cm^2 (over body)
$E_{nuc} = 5.5\%$ Body Average Efficiency 4π
then $C = 4 \times 100 \times 0.055$ = 22 cps

^{60}Co Beta on Body (unsummed) – standard grille – US limit

If $A = 0.83$ Bq/cm^2
$a = 100$cm^2 (over body)
$E_{nuc} = 5.5\%$ Body Average Efficiency 4π
then $C = 0.83 \times 100 \times 0.055$ = 4.6 cps

^{60}Co Gamma (Gross) on Body (unsummed)

If $A = 40$ Bq/cm^2
$a = 100$cm^2 (over body)
$E_{nuc} = 10\%$ Body Average Efficiency 4π
then $C = 40 \times 100 \times 0.1$ = 400 cps

Probability – Sigma and %

Table 1 Probability - Sigma and %

Sigma	Probability
0.0	50.00%
0.1	53.98%
0.2	57.93%
0.3	61.79%
0.4	65.54%
0.5	69.15%
0.6	72.57%
0.7	75.80%
0.8	78.81%
0.9	81.59%
1.0	84.13%
1.1	86.43%
1.2	88.49%
1.3	90.32%
1.4	91.92%
1.5	93.32%
1.6	94.52%
1.7	95.54%
1.8	96.41%
1.9	97.13%
2.0	97.72%
2.1	98.21%

Sigma	Probability
2.2	98.61%
2.3	98.93%
2.4	99.18%
2.5	99.38%
2.6	99.53%
2.7	99.65%
2.8	99.74%
2.9	99.81%
3.0	99.87%
3.1	99.90%
3.2	99.93%
3.3	99.95%
3.4	99.966%
3.5	99.977%
3.6	99.984%
3.7	99.989%
3.8	99.993%
3.9	99.995%
4.0	99.997%

This probability refers to either the Probability of Detection or the Probability of NOT triggering a False Alarm. These probabilities are calculated and displayed in Detection Options (page 5-16)**.**

Setting of Alarm Levels, False Alarm Rates & Probabilities

Contamination Alarm Levels and associated averaging areas are generally driven by legislation. However, programming of statistical detection certainty (Probability of Detection) and False Alarm rates are often local site decisions which impact on the Monitoring Time and equipment ‘credibility’ with the users. High false alarm rates quickly loose user confidence in the integrity of the measurement, while too stringent statistical requirements extends monitoring times resulting in low ‘throughput’ and frustrated queues of users.

The following discussion is intended to draw attention to the issues involved, their consequences and practical solutions. These scenarios are similar for most common nuclide types and energies, but particularly acute in the case of low-energy betas.

A statistical demonstration program, available from Thermo Fisher Scientific, provides numerical solutions to given

conditions and also gives a graphical representation, which is a valuable aid to understanding the effects and interactions of parameters.

Detector efficiency and averaging area are the variables that affect the Alarm set point count rate (C), above background. For beta emitters:

C = {Alarm activity per unit area x averaging area x detection efficiency (4π)}

Using the ^{60}Co efficiency values from Specification (page 3-1) and the US alarm limit:

^{60}Co on Body:	$C = (0.83\ Bq/cm^2 \times 100cm^2 \times 5.5\%$ (4π))	= 4.6 cps

Consider the graphical representation in Figure 13. The ^{60}C body alarm level of 4.6 cps is the centre of the right-hand distribution at 9.6 cps (4.6 cps above the average 5 cps background).

Alpha & Beta on Hands & Feet

The hands and feet are in defined positions and in contact with the detector surface, and so it is perfectly legitimate to use contact efficiencies when calculating alarm levels – values used should be to *activity (4π)* or ½ Surface Emission Rate as above.

Beta on Body

The use of body positioning systems, and the geometry of the instrument force most part of the body to be in contact with a detector at some point of the measurement cycle. However there will be some parts of the body where there is a small distance to the closest detector. For the purpose of this example, we use Body Average Efficiencies based on a closest approach to a body detector of 5 cm (as defined in IEC 61098). However this model is pessimistic for the sculpted geometry of the iPCM12.

Hands, Feet and Body (which includes the head) each have separate Alarm Levels, but for any given nuclide energy, the body alarm level will always be most stringent, dictating the monitoring time and thus, user throughput. Monitoring time will be significantly increased in higher backgrounds.

Alpha on Body

The alpha Alarm Level is generally used as 0.4 Bq/cm². With a body grille contact efficiency of around 15% *(4π)*, the body alarm level will be:

Alarm Level Count-rate (C)	= (0.4 Bq/cm² × 100 cm² × 0.15)	= 6 cps

Since the alpha background counts is generally low, typically 0.025 cps and theoretically no more than 0.1 cps, the alarm level is generally easily achievable and the beta body alarm level dictates the Monitoring Time (T)

In instances where alarm levels up to an order of magnitude lower (0.04 Bq/cm²) are required, the alarm count rate (C) will be around 0.6 cps. Although this level is theoretically achievable, in practice ***only 4*** Radon events reaching the detector will cause a false alarm!

The calculations in the instrument are based on a Gaussian model, which is valid for gamma and beta measurements. However the model used, has variation which makes it a closer approximation of the Poisson distribution at the very low count rates, associated with alpha measurements.

Effect of Probability of False Alarm (F)

This is the probability of a false alarm occurring due to natural background fluctuations.

The Background (B) for each detector is continuously monitored on a 100-second rolling average – represented by the sharply defined left-hand peak in figure 6.10. It is centered about the average background (B) and is a relatively tight distribution since it is measured over 100 seconds, statistically accurately known and thus, has a relatively small effect on monitoring time.

However, statistical background fluctuations, during the relatively short (often less than 10 seconds) monitoring time, are significant and likely to cause false alarms, unless corrected for. In figure 6.10 the wider left-hand peak represents the distribution about the 5 cps average background (B) in the monitoring time (T).

False alarm correction is achieved by the probability of false alarm factor (F) operating on the stored average background (B). This effectively produces a modified value of the background, for use in the statistical calculations, beyond which the probability of natural fluctuation is known to be acceptably small. In Figure 6.10 the modified background used in the statistical calculations, is represented by the left-hand vertical line. In this instance, the stored background average B of 5 cps is corrected to ~9.8 cps for use in calculation of the optimum monitoring time to give a false alarm rate of at least

the value of F entered. (The stored average background value of (B) for each detector is retained, unaltered by calculations).

The False alarm rate is important and should, however, be kept as low as practicable, since high frequency of false positives quickly degrades instrument credibility and user confidence. In practice, 1 in 1,000 false alarms are widely accepted for personnel monitoring. Since a false positive on *only one* of the detectors, in either half of the measurement cycle gives a false alarm, the value of F used must reflect the total number of detectors in the whole measurement. Depending upon detector options fitted, for a maximum of 60 detectors, a value of 4.2 sigma ensures a maximum of 1 in 1,000 false alarms for the whole system.

Use of the "Auto-recount" option in the Software may be useful. This will automatically require the user to re-monitor in the event of a alarm announcing only the final measurement result. This significantly reduces the probability of two consecutive false alarms due to background variation and avoids unnecessary "recordable incidents". It also has the benefit of automatically confirming real alarms.

Effect of Probability of Detection (PoD)

This is the probability that *exactly* one Alarm Level of Contamination will be detected.

The rate of detecting *exactly* one Alarm Level of emissions is, on average, 50% or 0 sigma. In Figure 6.10, the right-hand peak represents the distribution about the Contamination alarm level (C) during the Monitoring Time (T). In this instance the alarm level (C) is set 4.6 cps above the average Background (B) of 5 cps.

A higher detection rate may be desired, and can be achieved by modifying the contamination alarm level set point by the probability of detection (P). This effectively 'backs off' (reduces) the alarm level creating a lower contamination count 'triggering threshold', represented by the right-hand vertical line in figure 6.10. In this instance, the alarm level count-rate is adjusted to ~3.2 cps above the background (B) to achieve 1.65 sigma (95%) Probability of detecting ***exactly one*** alarm level of contamination.

Increased probability of detection (P), effectively reduces the Alarm Level causing a corresponding increase in the monitoring time (T), to achieve the false alarm rate (F).

When measuring low energy beta emitters and alpha emitters small body movements will drastically affect the sensitivity - a movement of a few centimeters may change the sensitivity by up to an order of magnitude. This variation would be far more significant than stringent selection of probability of detection.

Monitoring Time (T)

Judicious setting of the Probability of False Alarm and Probability of Detection, as described previously will keep monitoring times to a minimum and maintain personnel throughput.

Calculation of the Minimum Monitoring Time

Consider Figure 13. As discussed earlier, the left-hand vertical line represents effective background count adjusted to achieve the required measurement False alarm rate (F) (in this instance 1 in 1,000) in the monitoring time (T). Also as discussed earlier, the right-hand vertical line is the alarm level count-rate adjusted to achieve the required Probability (P) of detecting *exactly one* alarm level of contamination (in this instance 1.65 sigma {95%}) in the monitoring time (T).

The 'positive separation' between the modified background and alarm counts, indicates that the set of conditions presented in Figure 6.10 can be achieved in a 15 second monitoring time, with an "Operational Margin". This operational margin would therefore accommodate a more stringent set of parameters, which in practice is likely to be an increase in the background (B). However, for the set of conditions presented, the user is being monitored *beyond* the precision and certainty required, thus effectively 'wasting time' – which reduces throughput.

Therefore, the iPCM12 software continuously adjusts the monitoring time (T) to the minimum required to achieve the statistical requirements, as the background changes. This is reflected in Figure 14, which shows that the monitoring requirements can be achieved in less than 11 s. Note that the iPCM12 rounds the monitoring time up to the nearest whole second. The point where the two vertical lines *just meet,* is the absolute limit of detection – effectively the alarm trigger point above the average background.

High Background

Any change in background (B) will result in a monitoring time adjustment. If a background increase requires the monitoring time to exceed the iPCM12 user programmed *maximum* (T_{max}) a "high background" condition exists. In graphical terms, the two vertical lines have c*rossed over* into a 'negative separation' condition, and the monitoring time can no longer be increased to restore the balance.

In this situation, either the maximum monitoring time (T_{max}) must be increased; the Alarm count increased or the statistical requirements (P and/or F) must be relaxed for the instrument to resume operation. This is a "non-fatal" condition from which

the iPCM12 will automatically recover if the background (B) falls to an acceptable level.

Operational Margin

In Figure 13 the 'positive separation' between the modified background and alarm counts indicate an operational margin exists for the given parameters.

Figure 14 shows the monitoring time T adjusted to 11 seconds, ***just*** balancing the statistical equation with variables F, P, B, and C – the positive separation is approaching zero. If T_{max} is greater than T, then an operational margin exists and allows T to increase dynamically to compensate for any variable changes – usually background.

If, however, T increases to the point where it is verging on T_{max}, the system is at the absolute statistically allowable limit – effectively balanced on a "statistical knife edge" and there is no "Operational Margin" to compensate for change in any quantity. A ***fractional*** increase in the background (B) from any one detector will force the IPM into a "High background" state!

In practice, programming T_{max} to **just** balance the statistical parameters in the prevailing background condition leaves no 'operational margin' and should be avoided. It will cause the iPCM12 to switch between normal operation and 'High Background' with the slightest background drift from any detector, effectively rendering it unusable.

Having decided on statistical requirements, always program T_{max} to cope with the worst case background condition expected. The iPCM12 will dynamically adjust T to achieve the required statistical certainty in the minimum monitoring time to maximise throughput and minimises HP/guardian intervention.

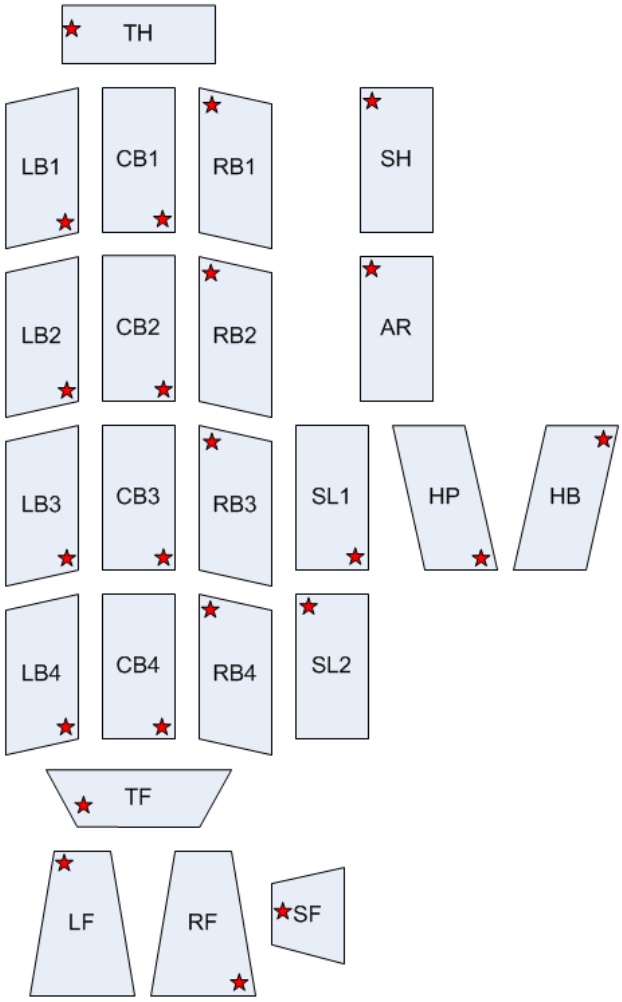
User Throughput

With fairly short monitoring times, e.g. 3 to 5 seconds each-way, user throughput largely depends upon ease of entry and exit, familiarity and ease of use of the monitor. A 5 second each-way monitoring time will allow familiar users to pass through the iPCM12 within 20 seconds, i.e. 3 plus personnel per minute.

Detector Naming

Gas Flow Detector Naming

The gas flow detector map is shown below:



Mnemonic	Detector
TH	Top of Head
LB1	Left Body Array Level 1 (Top)
CB1	Centre Body Array Level 1 (Top)
RB1	Right Body Array Level 1 (Top)
SH	Side of Head / Shoulder
LB2	Left Body Array Level 2
CB2	Centre Body Array Level 2
RB2	Right Body Array Level 2
AR	Upper Arm
LB3	Left Body Array Level 3
CB3	Centre Body Array Level 3
RB3	Right Body Array Level 3

SL1	Side of Leg Upper
LB2	Left Body Array Level 4 (Bottom)
CB4	Centre Body Array Level 4 (Bottom)
RB4	Right Body Array Level 4 (Bottom)
SL4	Side of Leg Lower
HP	Hand Palm
HB	Hand Back
TF	Top of Foot
LF	Left Foot Sole
RF	Right Foot Sole
SF	Side of Foot

Adjacent Horizontal Quadrants Left & Centre	
LB1A	CB1A
LB1B	CB1B
LB1C	CB1C
LB1D	CB1D
LB2A	CB2A
LB2B	CB2B
LB2C	CB2C
LB2D	CB2D
LB3A	CB3A
LB3B	CB3B
LB3C	CB3C
LB3D	CB3D
LB4A	CB4A
LB4B	CB4B
LB4C	CB4C
LB4D	CB4D

Adjacent Horizontal Quadrants Centre & Right	
CB1A	RB1A
CB1B	RB1B
CB1C	RB1C
CB1D	RB1D
CB2A	RB2A
CB2B	RB2B
CB2C	RB2C
CB2D	RB2D
CB3A	RB3A
CB3B	RB3B
CB3C	RB3C
CB3D	RB3D
CB4A	RB4A
CB4B	RB4B
CB4C	RB4C
CB4D	RB4D

Adjacent Horizontal Quadrants, Right and Side	
RB1A	SHA
RB1B	SHB
RB1C	SHC
RB1D	SHD
RB2A	ARA
RB2B	ARB
RB2C	ARC
RB2D	ARD
RB3A	SL1A
RB3B	SL1B
RB3C	SL1C
RB3D	SL1D
RB4A	SL2A
RB4B	SL2B
RB4C	SL2C
RB4D	SL2D

Adjacent Side with Opposing detectors on next step	
SHA	LB1A-2
SHB	LB1B-2
SHC	LB1C-2
SHD	LB1D-2
ARA	LB2A-2
ARB	LB2B-2
ARC	LB2C-2
ARD	LB2D-2
SL1A	LB3A-2
SL1B	LB3B-2
SL1C	LB3C-2
SL1D	LB3D-2
SL2A	LB4A-2
SL2B	LB4B-2
SL2C	LB4C-2
SL2D	LB4D-2

Adjacent Horizontal	
LB1A-2	CB1A-2
LB1B-2	CB1B-2
LB1C-2	CB1C-2
LB1D-2	CB1D-2
LB2A-2	CB2A-2
LB2B-2	CB2B-2
LB2C-2	CB2C-2
LB2D-2	CB2D-2
LB3A-2	CB3A-2
LB3B-2	CB3B-2
LB3C-2	CB3C-2
LB3D-2	CB3D-2
LB4A-2	CB4A-2
LB4B-2	CB4B-2
LB4C-2	CB4C-2
LB4D-2	CB4D-2

Adjacent Horizontal	
CB1A-2	RB1A-2
CB1B-2	RB1B-2
CB1C-2	RB1C-2
CB1D-2	RB1D-2
CB2A-2	RB2A-2
CB2B-2	RB2B-2
CB2C-2	RB2C-2
CB2D-2	RB2D-2
CB3A-2	RB3A-2
CB3B-2	RB3B-2
CB3C-2	RB3C-2
CB3D-2	RB3D-2
CB4A-2	RB4A-2
CB4B-2	RB4B-2
CB4C-2	RB4C-2
CB4D-2	RB4D-2

Adjacent Horizontal	
RB1A-2	SHA-2
RB1B-2	SHB-2
RB1C-2	SHC-2
RB1D-2	SHD-2
RB2A-2	ARA-2
RB2B-2	ARB-2
RB2C-2	ARC-2
RB2D-2	ARD-2
RB3A-2	SL1A-2
RB3B-2	SL1B-2
RB3C-2	SL1C-2
RB3D-2	SL1D-2
RB4A-2	SL2A-2
RB4B-2	SL2B-2
RB4C-2	SL2C-2
RB4D-2	SL2D-2

SHA-2	LB1A
SHB-2	LB1B
SHC-2	LB1C
SHD-2	LB1D
ARA-2	LB2A
ARB-2	LB2B
ARC-2	LB2C
ARD-2	LB2D
SL1A-2	LB3A
SL1B-2	LB3B
SL1C-2	LB3C
SL1D-2	LB3D
SL2A-2	LB4A
SL2B-2	LB4B
SL2C-2	LB4C
SL2D-2	LB4D

Vertical Quadrants Left	
LB1A	LB1B
LB1B	LB1C
LB1C	LB1D
LB1D	LB2A
LB2A	LB2B
LB2B	LB2C
LB2C	LB2D
LB2D	LB3A
LB3A	LB3B
LB3B	LB3C
LB3C	LB3D
LB3D	LB4A
LB4A	LB4B
LB4B	LB4C
LB4C	LB4D

Vertical Quadrants Centre	
CB1A	CB1B
CB1B	CB1C
CB1C	CB1D
CB1D	CB2A
CB2A	CB2B
CB2B	CB2C
CB2C	CB2D
CB2D	CB3A
CB3A	CB3B
CB3B	CB3C
CB3C	CB3D
CB3D	CB4A
CB4A	CB4B
CB4B	CB4C
CB4C	CB4D

Vertical Quadrants Right	
RB1A	RB1B
RB1B	RB1C
RB1C	RB1D
RB1D	RB2A
RB2A	RB2B
RB2B	RB2C
RB2C	RB2D
RB2D	RB3A
RB3A	RB3B
RB3B	RB3C
RB3C	RB3D
RB3D	RB4A
RB4A	RB4B
RB4B	RB4C
RB4C	RB4D

Vertical Quadrants Sid	
SHA	SHB
SHB	SHC
SHC	SHD
SHD	ARA
ARA	ARB
ARB	ARC
ARC	ARD
ARD	SL1A
SL1A	SL1B
SL1B	SL1C
SL1C	SL1D
SL1D	SL2A
SL2A	SL2B
SL2B	SL2C
SL2C	SL2D

Vertical Quadrants Left	
LB1A-2	LB1B-2
LB1B-2	LB1C-2
LB1C-2	LB1D-2
LB1D-2	LB2A-2
LB2A-2	LB2B-2
LB2B-2	LB2C-2
LB2C-2	LB2D-2
LB2D-2	LB3A-2
LB3A-2	LB3B-2
LB3B-2	LB3C-2
LB3C-2	LB3D-2
LB3D-2	LB4A-2
LB4A-2	LB4B-2
LB4B-2	LB4C-2
LB4C-2	LB4D-2

Vertical Quadrants Centre	
CB1A-2	CB1B-2
CB1B-2	CB1C-2
CB1C-2	CB1D-2
CB1D-2	CB2A-2
CB2A-2	CB2B-2
CB2B-2	CB2C-2
CB2C-2	CB2D-2
CB2D-2	CB3A-2
CB3A-2	CB3B-2
CB3B-2	CB3C-2
CB3C-2	CB3D-2
CB3D-2	CB4A-2
CB4A-2	CB4B-2
CB4B-2	CB4C-2
CB4C-2	CB4D-2

Vertical Quadrants Right	
RB1A-2	RB1B-2
RB1B-2	RB1C-2
RB1C-2	RB1D-2
RB1D-2	RB2A-2
RB2A-2	RB2B-2
RB2B-2	RB2C-2
RB2C-2	RB2D-2
RB2D-2	RB3A-2
RB3A-2	RB3B-2
RB3B-2	RB3C-2
RB3C-2	RB3D-2
RB3D-2	RB4A-2
RB4A-2	RB4B-2
RB4B-2	RB4C-2
RB4C-2	RB4D-2

Vertical Quadrants Sid	
SHA-2	SHB-2
SHB-2	SHC-2
SHC-2	SHD-2
SHD-2	ARA-2
ARA-2	ARB-2
ARB-2	ARC-2
ARC-2	ARD-2
ARD-2	SL1A-2
SL1A-2	SL1B-2
SL1B-2	SL1C-2
SL1C-2	SL1D-2
SL1D-2	SL2A-2
SL2A-2	SL2B-2
SL2B-2	SL2C-2
SL2C-2	SL2D-2

Right Hand Palm			
HPA	HPB	HPC	HPD

Left Hand Palm			
HPA-2	HPB-2	HPC-2	HPD-2

Top Left Toe	
TTA	TTB

Full Toe Left			
TTA	TTB	LFA	LFB

Sole Left - step 1			
LFA	LFB	LFC	LFD

Sole Left - step 2			
RFA-2	RFB-2	RFC-2	RFD-2

Side Foot Left			
SFA-2	SFB-2	SFC-2	SFD

Total Head Step 1			
THA	THB	THC	THD

Left Top Head			
THA	THB	THC-2	THD-2

Right Hand Back			
HBA	HBB	HBC	HBD

HBA-2	HBB-2	HBC-2	HBD-2

Top Right Toe	
TTC	TTD

Full Toe Right			
TTC	TTD	RFA	RFB

Sole Right - step 1			
RFA	RFB	RFC	RFD

Sole Right - step 2			
LFA-2	LFB-2	LFC-2	LFD-2

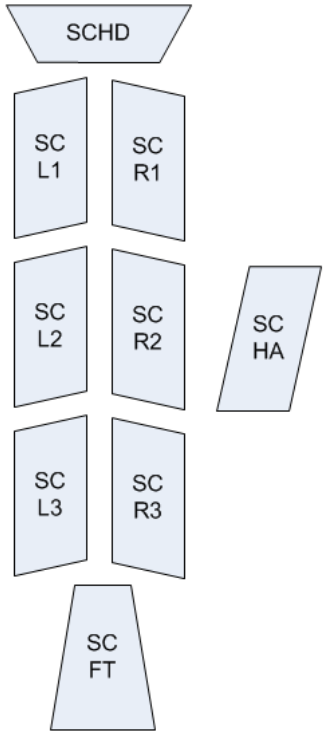
Side Foot Right			
SFA	SFB	SFC	SFD

Total Head Step 2			
THA-2	THB-2	THC-2	THD-2

Right Top Head			
THA-2	THB-2	THC	THD

Figure 12 Gas Detector Sum Zones

Scintillation Detector Naming



Mnemonic	Detector
SCHD	Scintillation Head
SCL1	Scintillation Left Body 1
SCL2	Scintillation Left Body 2
SCL3	Scintillation Left Body 3
SCR1	Scintillation Right Body 1
SCR2	Scintillation Right Body 2
SCR3	Scintillation Right Body 3
SCHA	Scintillation Hand
SCFT	Scintillation Foot

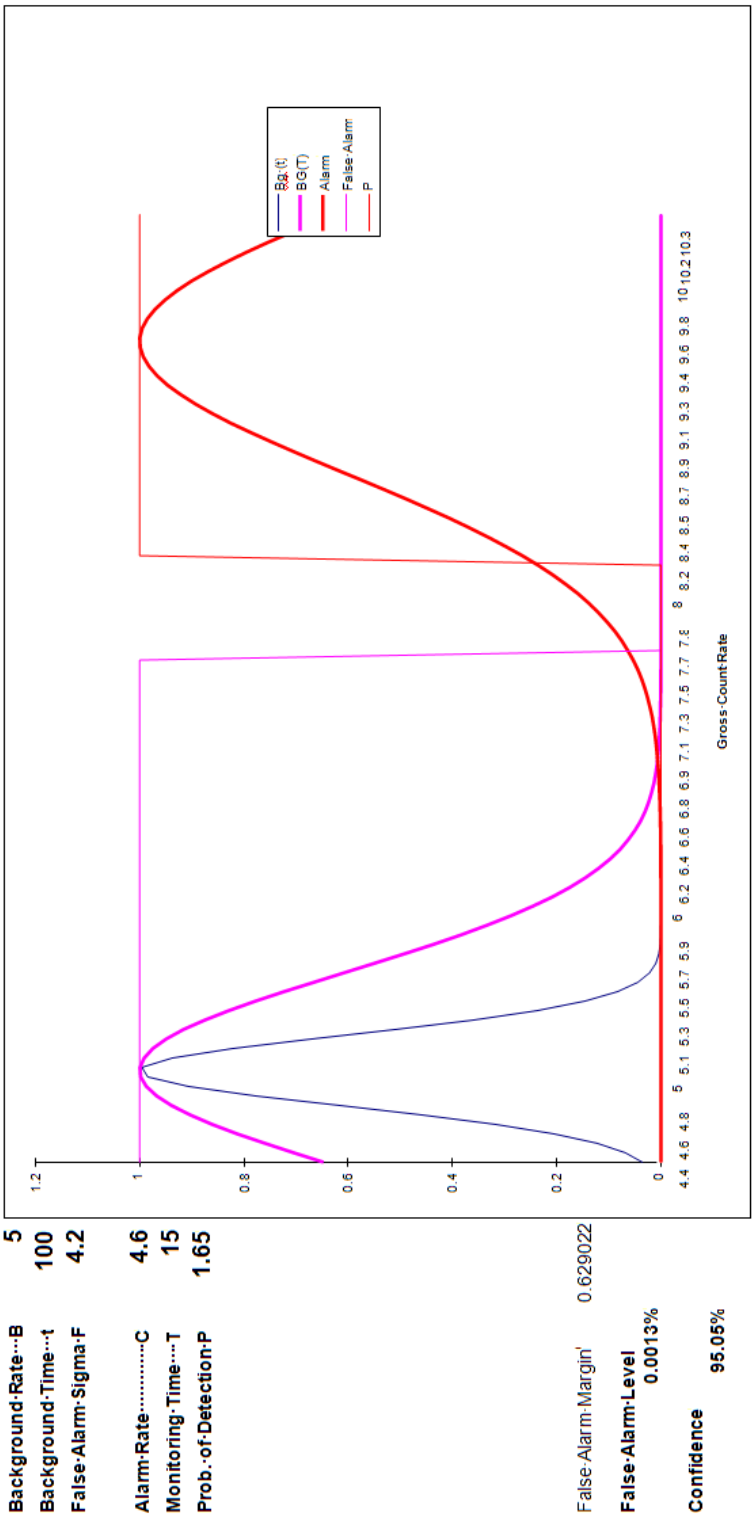


Figure 13 Monitoring Statistics showing "Operational Margin"

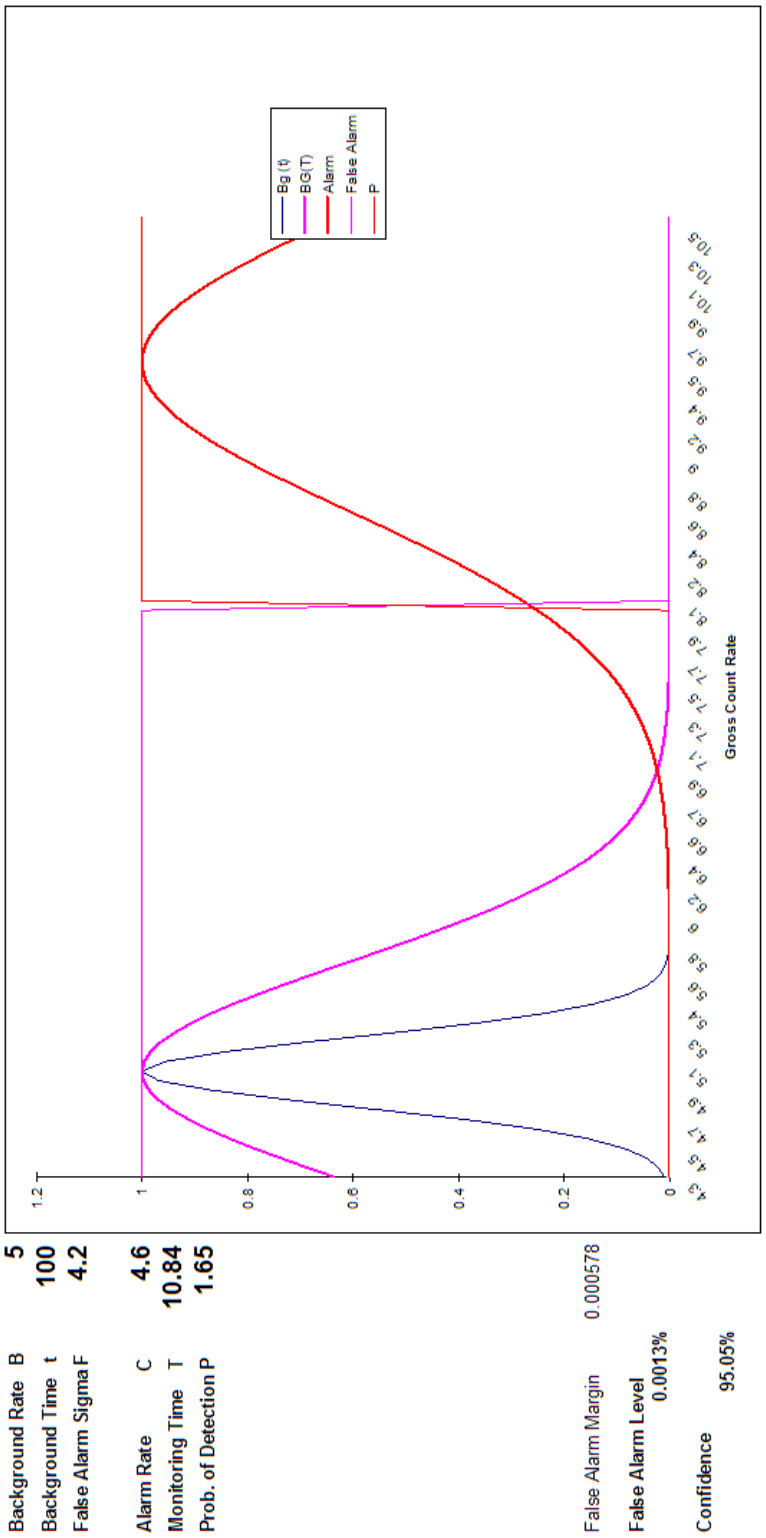


Figure 14 Monitoring Statistics showing "Minimum Monitoring Time"

Chapter 7 Technical Description – Circuitry

Description (page 2-1) provides a general background to the following description and should be read before proceeding.

Introduction

This section outlines the operation and function of all the major electronic assemblies which comprise the iPCM12. Description of all assemblies is restricted to general operation and specification since detailed circuit operation may be the subject of design confidentiality. The main circuit boards described here include:

5703A	Battery Controller	Controls and monitors charging / discharging of battery
5704A	Quad Amplifier Board	Proportional gas amplifier with four channels
5709A	Gas control Board	Monitors and controls flow of gas through system
5711A	Guidance Display	Provides guidance to user for correct positioning and time for monitoring
5712A	ETX Processor Board	Main processor board
5713A	HV Generator Board	Generates the HV for the Gas proportional counters
5714B	DC/DC Converter Board	Produces 5 and +/-12V for system from unregulated (battery backed) DC power

Reference to General Assembly D92591 and family tree D92425 shows the interconnections between the main iPCM12A modules:

1. Electronic display chassis assembly D92520/A (see Electronics display chassis D92520/A (page 2-2))

   This is the processing centre for the iPCM12 which includes the power management circuitry.

2. Guidance display assemblies 5711A and 5672A (see Annunciators Type 5711A and 5672A (page 2-4)).

   This includes LED cluster indicators.

3. Sensor assemblies and interconnections.

   Gas sensor data is connected via the local network cabling. Positioning sensors are powered and controlled via adjacent 5704A detector electronics and data is communicated via the local network cabling.

4. Detector assemblies 5710A (see 5710A Gas Flow Counter and 5704A Quad Amplifier (page 7-6))

   Each rectangular gas flow detector has 4 discrete detector regions, each wired to the quad amp board mounted on the rear of the detector housing.

5. Touchscreen colour graphics LCD assembly D92583/A is mounted on the rear of the Electronics display chassis so that the display is easily visible to the user standing inside the iPCM12 (see LCD Display and Controller I/F & Backlight Inverter Module (Assembly D92583/A) (page 7-9)).

Reference to General assembly D92777 (for closed booth iPCM12B & iPCM12C door variants only) shows additional interconnections between the following modules:

1. Power door GPIO interface 5707A (see iPCM12C option - GPIO Controller Card 5707A (page 7-10))
2. Barrier Mechanism (see iPCM12C option - GPIO Controller Card 5707A (page 7-10))
3. Swing door interfacing

Items only applicable to scintillation versions of iPCM12B and iPCM12C when fitted with gamma detector option kit AE0222A are:

1. Scintillation HV amplifier FHT681 (see iPCM12B or iPCM12C with Gamma Kit including FHT681 Scintillation HV & Amplifier (page 7-8))
2. Body scintillator 5717A (see Scintillation Detectors Type 5708A & 5717A (page 2-5))
3. Head, foot & hand scintillation detector 5708A (see Scintillation Detectors Type 5708A & 5717A (page 2-5))

Electronic Display Chassis D92520/A

The majority of the electronics is contained on board this sub-structure allowing easy removal for servicing.

The assembly contains the following modules:

1. X channel controller board 5712A (see ETX Controller Board – type 5712A (page 7-3))
2. Hard disk drive A92083/A
3. Gas flow control chassis including 5709A gas flow board (see 5709A Gas Control Board (page 7-6))
4. DC-DC converter 5714B (see 5714B DC/DC Converter Board (page 7-7))
5. HV Generator module 5713A (see 5713A HV Generator Board (page 7-7))
6. 150W PSU module
7. Battery control board 5703A (see Battery Controller Board Type 5703A (page 7-5))
8. Quad USB outputs

ETX Controller Board – type 5712A

This controller board comprises all the interface buffers and connections necessary to communicate between all peripherals and the proprietary on-board plug-in ETX processor.

The assembly has the following facilities used by the system:

1. 1.5GHz Pentium-M processor.
2. 512 megabytes of RAM.
3. Dual RS232 Serial communication interface.
4. Real time clock supported by an off-board Lithium battery. The RTC provides microprocessor access to year, month, day, hour, minute, seconds. It also provides several interrupt periods from one year down to 0.01 seconds
5. Quad USB hub
6. Single Ethernet interface
7. LCD and CRT drivers
8. Dual IDE ports
9. Flash Card interface
10. Audio synthesizer

Summary of 5712A functions

Function	Source	Destination	Comments
VGA/CRT	SK3		Display interface available for diagnostics
LCD drive	PL6	Touchscreen	LVDS cable
LED control	PL8, 9	5711A & 5672A	Visual indicators
Backlight	PL7	Touchscreen	Fixed intensity
Touch control	PL2, 4	Touchscreen	RS232 interface
USB power controllers	SK4, 11, 15, 16	Lower LCD panelling	Provides independent power sources with current limiting for USB peripherals
External Network	SK201	Upper mainframe	
X channel network	SK1, 6, 7, 8, 13, 14	Gas detectors, HV generator, gas controller	Internal network cabling
Loudspeaker	PL1	Upper mainframe	Loudspeaker drive from the on-board (ETX) sound generator
Power switching	PL10	DC/DC converter	5714B
Power switching	PL5	Battery controller	5703A
Fan control	PL13		Not used
Primary IDE	SK10	Electronic chassis	44 pin /2.5" Disk Interface
Secondary IDE	PL15	Compact flash	40 pin /CD Rom Interface
Power	PL20	DC/DC converter	5714B

COM port1 RS232 voltage levels on PL2 as follows:

Label	Connection PL2	Function
TXD	5	Transmit Data
RX-EXT	3	Receive Data
DTR	7	Data Terminal Ready
RTS	4	Ready to Send
DCD	1	Data Carrier Detected
CTS	6	Clear to Send
RI	8	
DSR	2	Data Set Ready

Battery Controller Board Type 5703A

This is an X-channel device which enables the operating system to monitor the charging process and remotely shut down the load. (Later iPCM12's may be fitted with 5720A controllers).

The Battery Controller Board, type 5703A, controls the DC voltage output of a power converter unit (PL4) between the range +11.2 V to +15.6 V in order to maintain the integrity of the +12 V 15 Ah Lead Acid Battery (PL3), over the operating temperature range (temperature sensor on PL1).

The 5703A has the ability to switch the load (PL6) ON/OFF as directed by the operator, whilst continuing to charge the battery. Current and voltage monitoring (IC100/101) and control circuitry (IC4) always ensure sufficient power is made available to power the iPCM12 (even when the battery is exhausted) from the primary power source.

The transfer to battery is automatic. However the load will be removed when the battery terminal voltage falls bellow +10.5 V. This circuit is required to prevent the battery being damaged by being deeply discharged. Hysteresis is built in to this circuit to prevent oscillations. It does not allow the battery to re-connect as soon as its terminal voltage recovers slightly as a result of having the load removed from its terminals.

The user is signaled the pending shut-down in order that any data can be saved.

A key switch is connected to the 5703A for manually switching the power ON/OFF to the load.

Keyswitch Operation

The key-switch performs two operations.

Primarily it allows the instrument to be switched ON if either the mains supply exists or the battery contains sufficient charge, or both. This is achieved by turning the key clockwise for at least 2 seconds.

Secondly, the instrument can be switched OFF should the operating software fail to carry out the "Shut-down" task by holding the key clockwise for at least 10 seconds.

5710A Gas Flow Counter and 5704A Quad Amplifier

The 5710A gas counter comprises 4 separately wired rectangular detector zones within an aluminium body, and an aluminized conductive mylar window.

A 5704A quad amplifier is mounted on the rear of the 5710A. The single input HV has filtered HV connections to each of four anode terminals within the counter. Four separate amplifiers buffer and shape the alpha and beta pulses, then pass these to discriminators. High/low beta and alpha pulses are processed via IC13 prior to X channel interfacing at network connectors PL1 and PL2.

PL5 provides connections for initial IC13 and IC14 flash memory device programming.

Optical TX/RX input and control at +5V are provided via PL3 and PL4 for the user positioning sensors on the iPCM12.

5709A Gas Control Board

The 5709A is mounted on the gas flow chassis located above the ETX processor board. The X channel processor IC13 accepts data from the adjacent inlet flow and exhaust flow sensors, and controls up to 4 gas solenoids:- Inlet, Exhaust, Gas On/Off, System bypass.

Under normal usage with Argon/Methane gas the inlet solenoid is activated. Under gas purge conditions (controlled via the iPCM12 menu), the inlet and exhaust solenoids are activated, thus bypassing the gas restrictor tubing.

PL5 provides connections for initial IC13 and IC14 flash memory device programming.

PL10 and PL11 provide X channel interfacing.

5713A HV Generator Board

IC2 DAC calibration circuits and HV clock from the on board processor IC13 provide a step-up transformer input to generate the polarizing voltage for the gas flow detectors. Under software control a Cockroft-Walton style voltage tripler circuit boosts the generated output HV up to 4kV. Two filtered HV outputs are provided for use within the iPCM12.

PL1 and PL2 provide X channel interfacing.

PL5 provides connections for initial IC13 and IC14 flash memory device programming.

5714B DC/DC Converter Board

Regulated and filtered power lines of +5V and +12V and -12V are produced via 3 DC/DC converters mounted on this board. The output is routed to the adjacent ETX 5712A board.

5711A Guidance Display & 5672A LED Cluster Indicator

The upper plinth is fitted with a 5676A LED cluster board with 5 indicators showing the real time status of the iPCM12:

GREEN	Ready/Clear
WHITE	Count
YELLOW	Recount
RED	Alarm
BLUE	Out of service

Buffered drivers are provided at PL9 on the 5712A control board.

The 5711A guidance display board has a two digit LED indicator to show the count down on measurements. It also has 2 indicators showing the real time user status of the iPCM12:-

ORANGE – Position body facing detectors

WHITE – Position back to detectors

Buffered drivers are provided at PL8 on the 5712A board

iPCM12B or iPCM12C with Gamma Kit including FHT681 Scintillation HV & Amplifier

The Dual-Channel Scintillation HV and Amplifier board FHT681 provides the high voltages for two scintillation detectors. It also receives charge pulses from two detectors, amplifies them and discriminates between five energy levels. Independent counter values (five for each gamma channel) are generated every 100ms and stored in a 5 second buffer. In addition to that, 1s values are built from the 100ms values. All these values can be polled from the serial interface.

HV & Amplifier Connections

The HV sections are designed to provide independently adjustable polarising voltages for two scintillation detectors with working voltage ranges between 500V to 1400V.

The setting of high voltages and thresholds is done via the serial interface.

The 1st, 3rd and 4th counters for each channel form Cobalt coincidence pulses which are available on OUT1 & 2 connectors.

The card has six connectors.

PMT1 & 2 The scintillation detectors are connected via MHV connectors.

OUT1 & 2 Coincident outputs are on BNC connectors

X15 & X16: These connectors provide power supplies to the board and RS485 terminations:

X15 & X16	SIGNAL
1	EARTH
2	0V
3	RX-
4	TX-
5	Signal Ground
6	TX+
7	+5V
8	RX+
9	+5V

Mains Power Module (assembly 702947KJ)

The mains power supply is a proprietary high-frequency switched mode 150 Watt converter. The power module can accept a mains input of 85 V to 264 V, 47 Hz to 63 Hz, the output is between 12 and 18 V at a maximum of 8.33A. The actual output voltage is controlled remotely by the 5703A (or 5720A if fitted).

The power supply is capable of charging the battery at a maximum rate of 3.3 A, up to +40°C. This module contains AC Mains and dangerous DC switching voltages. It should not be operated with the protective cover removed or the mains ground (earth) conductor disconnected. It is not user serviceable and should be returned to Thermo Fisher's Service department for repair.

LCD Display and Controller I/F & Backlight Inverter Module (Assembly D92583/A)

The LCD module is fitted with an integral Cold Cathode Fluorescent (CCFL) back-light (which is replaceable if found faulty). The back-light is driven from a proprietary inverter, mounted in a small screened box within the display. The inverter generates dangerous high voltages and RF interference frequencies and should not be operated outside the box or with the display lid removed.

The LCD is controlled via a proprietary serial interface device also mounted in a small screened box within the display.

Four USB sockets are provided on the base of the assembly.

Neither the display or the back-light inverter or the controller are user serviceable and should be returned to Thermo Fisher's Service department for repair.

iPCM12C option - GPIO Controller Card 5707A

This is an X-channel device which enables the operating system to monitor and control the variant with "powered door" and "barrier arm". Up to eight isolated inputs and outputs are available.

Input/Output	Connection	Function
IP4	PL08 pin 1 & PL08 pin 2	Door CLOSED status
IP5	PL08 pin 3 & PL08 pin 4	Door OPEN status
IP0	PL09 pin 1 & PL09 pin 2	Barrier status DOWN
IP1	PL09 pin 3 & PL09 pin 4	Barrier status UP
RELAY 1	PL4 pin 2	Barrier drive -
RELAY 2	PL4 pin 5	Barrier drive +
RELAY 4	PL5 pin 2 & PL5 pin 3	Door control OPEN/CLOSED
INTERLOCK	PL13 pin 4 & PL13 pin 5	Emergency OPEN
POWER	PL1 pin 1 & PL1 pin 2	Barrier power + Barrier power -
X-channel/A/ FHT681s	PL6/10 way IDC	Current limited supply available

General Electromagnetic Compatibility (EMC) Considerations

The overall construction is designed to minimise the effects of mains and airborne interference and emissions.

It is, therefore, vital that the construction standard is maintained at all times, particularly when replacing parts and during servicing.

Earthing is particularly important for continued EMC (and Safety) performance. 'Hard' earthing of the mains inlet/filter assembly and LCD display tail, the HV/Amplifier FHT681 screening can and the frame earth are particularly important. Refer to the relevant Servicing instructions for details.

The instrument should only be operated with all earthing connections securely made and all screening covers fitted.

Chapter 8 Routine Checks

This section describes the routine checks required to ensure the correct operation of the iPCM12. Most mechanical and electronic failures, if they occur, will become apparent during normal operation and do not require checking. Therefore, they are not included in this section.

Mechanical Checks

iPCM12 Mounting Arrangement

During calibration, or more frequently if required, check any mechanical structure on which the iPCM12 may be mounted. The iPCM12C with the gamma option kit includes 1cm and 2cm areas of shadow lead shielding is very heavy. Mounting arrangements including the base spreader plate should be inspected for signs of deterioration, instability or any other factor which may affect safety of operation or maintenance. If any such defect is suspected, the iPCM12 should be withdrawn from service and safely removed using a suitable forklift and the integral fork lifting facilities provided. The mounting should be repaired and made safe before replacing the iPCM12.

Electrical Checks

Battery Charge state

During calibration, check the general condition of the battery. To do this, turn the iPCM12 ON by rotating the key-switch on the front panel to the ON position. Remove the mains power cord. Unlock and open the right hand side access panel and locate PL5 on controller card 5703A. Connect a suitable Voltmeter, set to the DC volts range, directly across the terminals of PL5 (pins 1 and 6). Check the "load" battery voltage is greater than 12 volts (assuming the battery has previously been charged). If the battery voltage is low, consult Troubleshooting (Operational) (page 11-21).

Alternatively the battery voltage and load can be monitored from within the application (see Battery (page 5-20) for further information).

NOTE: Only qualified personnel should operate the iPCM12 with the mains connected and the access panel open. Make sure all the warnings given at the front of this manual are heeded.

Display Checks

It may be necessary at some time (due to replacement of Touch Screen or Touch Controller) to re-calibrate the touch screen. This is an Administration function and the facility would be accessed outside of the application program.

EMC & Safety Earthing Checks

Periodically, and after Servicing, check all Earth connections are fitted and tight to ensure continued EMC performance and User Safety. These checks should include the screws and washers securing the mains inlet/filter assembly in the top chassis, all connections to the central earth point (CEP), and the connection to the main and side frames.

Also check that all screening covers are fitted and all fixings tightly secured.

Periodic Source Checks

During calibration, after repairs, or once a year, the detection efficiency of the iPCM12 should be checked using a Calibration check as described in Cal Check. To perform these checks, small area sources of the nuclides that the iPCM12 is required to detect should be used. A stable background is essential for an accurate result. The calibration check will be performed to an accuracy defined by Default Calibration Accuracy (%).

The overall Efficiency calibration factor should be within ±10% of the existing programmed value. Should the results be outside these limits, the iPCM12 operational parameters require revision (see Setting Up Procedure (page 9-1)).

Calibration procedures are described in Calibration Procedure (page 10-1).

Carry out a regular source check after a 100 sec background update.

Regular Source checks

Daily or weekly source checks are advisable, using a Calibration check as described in Cal Check (page 5-34).

For detector calibration, the check source needs to be placed in calibration positions coinciding with the geometric centre of all detectors. Typically ^{36}Cl or ^{99}Tc extended area sources are used for beta checking, and ^{241}Am for alpha checking.

An alternative is to undertake an Alarm Check, where a source of activity marginally greater than alarm level setting should be

held against each detector in turn. Each detector should alarm within the typical monitoring time.

Cleaning Instructions

WARNING: Ensure the mains supply is isolated before cleaning.

The display can be wiped clean with a dry cloth. Smudges may require the application of the Screen cleaner provided when the instrument was delivered.

The cubical should be cleaned using a mild detergent.

Make sure the equipment is completely dry before re-connecting the supply.

Chapter 9 Setting Up Procedure

Initial Setting Up for Use

General

After the initial installation and before switching on the iPCM12, read Operating Instructions (page 5-1). Connect the mains lead to the iPCM12 and turn the keyswitch clockwise until the unit switches on (a click is heard after about 1-2 seconds) and then release it (see Keyswitch operation (page 7-5)).

Initialisation

The iPCM12 will power up and load up the Windows XP operating system, followed by the iPCM12 application. During this time, the *Thermo Scientific* banner will be displayed (see below).

Once the application has loaded, the application will initialise (see Start Up Checks (page 5-71)). The system will automatically pass into the User Mode. In this mode, the user will not have access to any operational parameters. In order to set up the instrument the user requires a security dongle, which should be placed in the USB port of the iPCM12. When this dongle is in place, the touch screen is activated, and the user will have access to the Administrator Mode (page 5-1).

Setting Passwords

There are three user levels: Technician, Health Physicist and Thermo Fisher. The lowest level is *Technician* and allows the user to view some parameters and undertake calibration checks. The *Health Physicist* level gives access to all parameters that are used for calibration and setup of the instrument. The top level *Thermo Fisher* is reserved for the expert user since it gives access to specialised calibrations settings that fundamentally affect the performance of the instrument, and should only be set at the Thermo Fisher factory or by a Service engineer. See Passwords (page 5-64) for details regarding the default passwords. The menu options that are available to each user levels are summarised in Menu Roles (page 5-6).

Passwords (page 5-64) show how the user may change the password. Both the *Thermo Fisher* and the *Health Physicist* passwords protect the security of the operational Parameters and hence the integrity of the measurement. Therefore these passwords should remain confidential; their use restricted and above all should not be readily obvious to potential "hackers".

Each user level should have a unique password and under no circumstances should all three levels be assigned the same password.

Setting the Operational Parameters

At this point, it is strongly recommended that the following User Programmable Operational Parameters are checked and reset by the Health Physicist before allowing normal monitoring to proceed. As noted below, it may be helpful to consult the configuration report to view the parameter settings established during the factory test and calibration. A configuration printout is also normally provided with the initial documentation and iPCM12 manual.

Core parameters are noted here:-

Activity units: Bq, Ci, DPM

See Set-Up|Monitoring (page 5-12) for more information.

Low Background Limit (α, β, γ)
High Background Limit (α, β, γ)
Minimum Monitoring Time
Maximum Monitoring Time
Measurement Confidence
Gross changing background
Detector changing background
Changing Conditions
Changing Conditions period

See Set-Up |Monitoring (page 5-12)for more information.

Calibration Required Interval
Calibration confidence – *typically 2σ (~95%)*

See Set-Up|Calibration (page 5-15) for more information.

Quick Scan Period for β , γ

See Set-Up|Operation (page 5-10) for more information.

Calibration stream selection
α , β , γ , ^{60}Co Alarms

See Set-Up|Alarms (page 5-18) for more information.

Probability of False Alarm – *typically 3.1σ*
Probability of Detection – *typically 1.65σ*
α , β , γ , sumzones

See Set-up|Detection Options (page 5-16) for more information.

Resetting the above Parameters will guarantee the integrity of measurements. It is also important to reset the time and data (see Setup (page 5-62)) since these are used when check the calibration due dates, and also by the Data option.

A listing of all the parameters is available by selecting Configuration Report (page 5-56). This report should be either printed or saved to USB memory stick, when the instrument is first set up, and when significant changes of configuration are undertaken.

The iPCM12 will be delivered optimised with a valid HV Scan and optimum operating voltages stored. If the HV Scan needs to undertaken for any reason, follow the procedure described in HV Scan (page 5-41).

The details of the current and previous calibrations are stored to a backup compact flash. These backups take place automatically after every calibration, and when requested by the User. It is recommended that the backup is undertaken after every voltage scan and calibration. This backup may be retrieved if for any reason the hard drive on the instrument needs replacement.

Selection of Detector Operating Parameters

The following sections assume that the instrument is set to the factory defaults. Note that for all variants of iPCM12 the gas flow detector working voltages are the same (depending on the gas medium used), whereas gamma detector working voltages are specifically set for each PM tube/scintillator.

Detector HV Selection

The Test and Performance Certificate supplied with each instrument lists the recommended High Voltage settings for each detector for the optimum detection. HV Scan (page 5-41) describes the setting of the detector HVs.

If, however, it is required to ascertain the optimum operating voltages by measurement, e.g. due to new detectors, the procedure described in Derivation of the Optimum Operating Voltage (page 9-5) should be followed. Calibration for other nuclides and nuclide mixes is described in Calibration Procedure (page 10-1).

Derivation of the Optimum Operating Voltage

The iPCM12 is designed to detect activities down to release levels and otherwise 'as low as reasonably achievable - ALARA'. However, the iPCM12 is also very linear in response, so a wide range of source activities may be used for set-up and calibration.

For the **gas flow** detectors, typical beta and alpha extended area sources for contact measurements will be required around 0.1μCi (~4kBq) with a calibrated SER – surface emission rate- e.g. 2000β/sec and 2000α/sec.

Depending upon energy / detector efficiency, for **gamma** scintillation detectors, source activity should typically be in the 2 μCi (~80kBq) to 6 μCi (~200 kBq) range, and in any case not more than 10 μCi (370 kBq). Long count times will be required for small sources to maintain statistical accuracy against adverse background influences.

Performing the HV Scan

NOTE: For all the measurements performed below, all sources of radiation other than that used for the specific test, should be removed from the immediate area in order to minimise the effect of background fluctuations. All counts read from the detectors are corrected to compensate for the amplifier "dead time".

With the iPCM12 and surrounding area free of sources, enter the Administrator Mode (page 5-1)as 'Health Physicist'. From the function tabs on the left side of the screen select the 'Calibration' option. Then from the tabs along the top of the screen select 'HV Scan'.

There is a choice between displaying the gas flow HVscan (α / β) or if fitted the gamma HVscan (γ). There will then be a further choice between performing a 'New Scan' and viewing the 'Last Scan'. Press the 'New Scan' button.

The new screen allows for the setting of the scan parameters Start, Stop and Step voltages as well as the counting time.

The recommended values for these parameters are:

For **gas flow** detectors -

Start = 1400 volts

Stop = 2000 volts

Step = 5 volts

Time = 10 seconds

For **gamma** scintillation detectors -

Start = 600 volts

Stop = 1100 volts

Step = 5 volts

Time = 10 seconds

NOTE: Short voltage steps are required in order to make the location of the optimum operating voltage easier. Using the recommended values, this process will take approximately one hour to complete.

Once there parameters have been set and the 'Start' button has been pressed. A series of onscreen instructions are displayed to step the user through the scan process.

NOTE: The scan can be aborted at any time by pressing the 'Abort' button. The background scan is performed on all detectors simultaneously.

For the **gas flow** detectors, it is not obligatory to carry out HV scans unless the gas medium has been changed. This is because the characteristics of gas flow detectors have the same optimum working point which is typical of type. An HV scan for one gas flow detector is included in the factory testing to ensure the correct operation of the detectors. One HV scan for a beta source in contact with the detector grille, plus one HV scan for an alpha source in contact with the detector grille is normally sufficient to establish the correct gas flow working voltage for the whole instrument. This can be repeated for other detectors if deemed necessary.

Typically for the recommended P7.5 gas (7.5% Methane CH_4, 92.5% Argon) the optimum EHT working point for 5710A gas flow detectors is 1775V.

For the **gamma** detectors, the first step is to perform a background scan. This is followed by a scan with a ^{137}Cs source. The user has the option of selecting which detectors to scan.

The quickest method is to place the source in the centre of the portal at a location nominally 100cm above the treadplate and spaced 5cm from the face of the central detector and scan all the detectors simultaneously.

An alternative method is to scan the detectors in three phases.

First phase: place the source at a height of 50cm above the treadplate, and select the lower 2 gamma body detectors plus the foot detector for scanning.

Second phase: place the source at a height of 100cm above the treadplate, and select the central 2 gamma detectors plus the hand detector for scanning.

Third phase: place the source at a height of 150cm above the treadplate, and select the upper 2 gamma body detectors plus the overhead detector for scanning.

Another alternative method is to scan each detector individually, with the source in close proximity to the centre of each detector, i.e. nominally 3 inches (7.5 cm).

Thermo Fisher believe the optimum method is the three phase method, since this process ensures the source is in close proximity to the detectors being scanned, whilst minimizing overall test time.

On completion of the scan, the user is given the option of saving the data by pressing the 'Save Scan' button. This data, along with its description, can be retrieved via the 'Data' tab (see HV Scan (page 5-41)). Once the 'Save' button has been pressed, the display changes to show graphs of the scans.

Determining the operating voltage for mid-high energy nuclides

There are two methods for determining the optimum operating voltage depending on whether the low energy alarm will be used, or whether the voltages will be set the "classic" way by reviewing the Figure of Merit at each voltage setting. The recommended method is known as the NBR method, which typically will also provide an operating voltage which satisfies the Figure of Merit criteria. The NBR method must be used if the ^{60}Co window or low energy indications are enabled. The NBR method requires the use of a ^{137}Cs calibration source for voltage optimisation.

NBR method

When the graph of the voltage plots is displayed, press the detector on the screen mimic, and the respective graph for a detector which will expand it to fill the screen. Select the NBR button, and a ratio against operating voltage graph is displayed. The optimum operating voltage is that which has a T1/T2 ratio of between 30 and 35. In order to find this press the `Table' button and the data will be displayed. From the table, identify the operating voltage that has the correct T1/T2. If you have to interpolate between two voltages, assume a linear change. Enter this value into the `HV Setting' box and then press the `Back' button.

The value below the graph will now have a **Gold** background to it. This background colour highlights that the value has been changed, but not yet saved. When all operating voltages have been set, press the `Apply Settings' button to save these values.

NOTE: The `Back' button **must** be pressed in order to access the other functions.

Figure of Merit (FOM) method for gamma scintillation detectors

NOTE: The following procedure tends to be iterative in nature and included as a guide only. Different operational requirements and background conditions may necessitate a different choice of operating point. The final choice should be at the discretion of the senior Health Physicist.

When the gamma (γ) graphs are displayed, select the 'Gross Counting' option, and then press the respective graph for a detector which will expand it to fill the screen. Pressing 'Table' will show the actual FOM and S^2/B values – note that S^2/B is proportional to FOM and is included for those users who prefer this quantity.

For mid and high energies, an FOM 'peak' is usually evident from the data. Determine the maximum value of FOM for each detector - **as a starting point**. If no clear peak is visible or several peaks exist, select a starting FOM value corresponding to a background value (B) similar to that of the other detectors. Select the detector operating point as follows:

Test 1. Each background count does not differ by more than 30% from the mean value of all detectors.

Test 2. When the source to detector distance is the same, calculate the Mean Source Counts (Sm) for all detectors. The value of the net source counts (S) for each detector does not differ by more than 25% from the mean value of (Sm) for all.

If any detector exceeds any of these limits, alter the relevant HV by 10 V and check the FOM is not significantly different than the original. A total adjustment of 75 V is permissible.

This is a rough guide and individual circumstances may demand wider variations.

Test 3. If and when the background and source values are satisfactory, calculate the 4π gamma detector efficiencies, at the chosen HV setting. Calculate the overall system efficiency, which should be within ±10% of the 4π efficiencies noted below, which are measured at the contact face of the gas flow detector grille located nearest to the gamma detector:

Nuclide	Upper body(γ)	Lower body(γ)	Hand(γ)	Foot(γ)	Head(γ)
^{137}Cs (662 keV)	11.0%	5.9%	3.4%	8.4%	17.4%
^{60}Co (1.2 MeV)	21.5%	12.5%	7.7%	15.8%	25.0%

If the overall system efficiency or any individual detector efficiency is too low (or too high), consider the efficiency values at the next HV step - review the background Criteria in Tests (1) & (2) and the Source Criteria in Test (3). Repeat this process if necessary.

NOTE: The Minimum Detectable Activity (MDA) is proportional to the square root of the Background – lower background improves (reduces) the MDA. Therefore 'Squeezing' a few extra source counts at the expense of a significant background increase, will be detrimental.

Please also refer to iPCM12 Specification (page 3-1) and Technical Description - Physics (page 6-1) for details of Body average efficiencies and setting of operational Alarm levels.

Setting the Gas Flow detector High Voltage

Select the Gas Flow Detector Voltage parameter from the main menu, and set the correct working voltage to the nominal figures shown. This varies with the gas mixture in use and the recommended working voltages are indicated in Specification (page 3-1).

Typically for the recommended gas mixture P7.5 (7.5% Methane CH_4, 92.5% Argon), the working voltage is 1775V. Details are shown on the configuration print-out for the instrument at the time of manufacture.

Note: *The voltage quoted here is valid within ± 300 m (1000 ft) of sea level. The working voltage may reduce by as much as 25 V/300 m (1000 ft) above sea level.*

Gas System

Gas Supply

The Gas supply should be regulated 3 to 5 psi or 14 to 35 KPa or 0.15 to 0.35 Bar. Gas is Argon/Methane at mixture between 90%/10% (P10) and 95%/5% (P5). 92.5%/7.5% (P7.5) is recommended. Ensure that the Gas flow detector HV settings are correct for the gas mixture as noted in the previous section.

Leakage Checks

The gas inlet purge and flow rates are set using needle valves on the gas control chassis. Both needle valves need to be adjusted to bring the gas system fully into service. As a default, the gas controller can only deliver gas at the reduced "normal" gas flowrate, even if the purge rate has not been set. This avoids any possibility that the purge rate is inadvertently set at maximum, so if an iPCM12 is switched on without any gas adjustment there is no gas detector damage due to overpressure. The gas controller board holds the exhaust solenoid open and the restrictor is bypassed indefinitely.

Select Diagnosis and Gas Flow sub-menu to view the current gas status. With the Purge Mode selected on screen adjust the **manual needle valve** labeled "PURGE" on the gas chassis to set an INPUT PURGE flow of 200 cc/min ±5%. In this Mode the restrictor circuit is bypassed by solenoid. Note that turning the valve clockwise reduces the flowrate. Allow the gas system to stabilise for 10 minutes.

With Normal Mode selected on screen, the iPCM12 gas circuit reverts to normal flow rates. Adjust the **manual needle valve** labeled "NORMAL" on the gas chassis to set in INPUT NORMAL flow of 25 cc/min ±20%. After allowing the gas system to stabilise for 20 minutes, the inlet and outlet flow

meters should indicate identical flow rates. In practice, however, small discrepancies due to calibration errors, pressure changes and very small leaks are likely to exist. An outlet flow rate up to 10% less than the inlet flow rate is acceptable. A larger discrepancy indicates a leak, which may be isolated by "linking-out" sections of the gas circuit, referring to Gas Schematic D92591 sheet 4, or ideally by using a gas "sniffer".

The hot spare detector may be utilized to minimize instrument downtime when a detector is changed.

Note: The thin detector windows allow a rapid rise in the gas temperature and hence the volume as the gas moves through the system. This can cause the outlet flowmeter reading to appear greater than the inlet flow, until the gas system has stabilised.

Gas flow parameters

Normal mode High and Low gas flow limits plus purge limits and fault ratios are established by referring to the Setup menu and the Gas Flow sub-menu.

Typical parameter settings are:-

Normal Mode low limit	0cc/min
Normal Mode high limit	75cc/min
Purge Mode low limit	50cc/min
Leak ratio	50%
Average period	5 secs
Maximum stabilization period	60mins

The real-time operational gas status may be observed by referring to the Diagnostic menu and the Gas Flow sub-menu. The flow rates are shown as a simplified bargraph , which is updated in accordance with the average period set.

Purge and Operational Flow

Before the iPCM12 will function reliably, all of the air must be purged from the gas flow detectors. A rapid purge of between 200 and 300 cc/min for at least 4 hrs is preferable or alternatively a minimum purge of 12 hours (overnight) at 50 cc/min may be used.

Proceed as follows:

- Via the HP menu access, select the Diagnosis menu and Gas Flow submenu. Observe that the INLET PURGE flow is now set at about 200cc/min and although the restrictor is bypassed it will take about 10 minutes before the EXHAUST flow reaches this level. Note that temporarily a gas leak fault will be indicated.
- Wait 10 minutes and check the outlet flow is > 50 cc/min.

- If this is not the case, check for leaks and/or blockages.
- Perform 10 second Test Counts at half hour intervals until all gas flow detectors show similar and consistent count rates:
- A normal countrate will be approximately 7 to 8 cps in a low background (equivalent to ~ 80 to 100Sv/h cps/μSv/h for body, hand & foot detectors).
- Set the Mode switch to Normal which places the restrictor in circuit.
- Note that the typical Inlet flow rate will be between 20 and 25 cc/min for leak-free beta only systems. The flow rate may be set to 50cc/min for more “robust” operation and peak alpha efficiency.

Chapter 10 Calibration Procedure

This section deals in detail with primary system calibration. It includes background, source and efficiency checks on individual detectors to check detector balance as well as overall system efficiency. Primary system calibration by the Health Physicist is only usually necessary on initial installation and on a periodic audit basis. More frequent overall system calibration checks can be quickly carried out by Technician user level using the "Cal Check" facility (see Cal Check (page 5-34)). For more information regarding the user roles, see Foreword (page xv) and Menu Roles (page 5-6).

Note: Throughout this section examples are given in Bq. However, by first selecting nCi's from the Options Menu (see UI Options (page 5-8)) as the operating units, all values may be entered in these units. Of course the equations remain unchanged, though care must be taken to ensure that the units are consistent.

Calibration Validity

The iPCM12 is capable of undertaking a calibration validity check. This check will evaluate the number of days between the last valid (PASS) calibration check. If this number of days exceeds the maximum acceptable recalibration interval, then the iPCM12 will put itself "Out of Service" (see Out of Service (page 5-97)).

To define the period between calibrations checks, set the "Calibration Required Interval" parameter in Calibration (page 5-15).

If the user "Fails" the calibration check, then this is not treated as a calibration, and is disregarded when assessing whether the iPCM12 is within its recalibration interval.

Equipment Required

1. A radioactive source of known nuclide and activity, which is found within typical contamination to be monitored. The iPCM12 is designed to monitor radioactivity on the surface of the body to levels less than 83 (5000 dpm) for beta and 17 Bq (1000 dpm) for alpha. Planar sources or surface area less than or equal to 100 cm^2, and activities between 400 Bq and 6 kBq are used to calibrate detectors.
2. In order to speed up the calibration process, a 2 source jig to allow calibration of two detection zones, on a single detector, at the same time.

Preparation for Calibration

First the user must enter the Calibration Menu (page 5-33). Select HV Scan (page 5-41) and check the detector HV's are set correctly for the Calibrating isotope. If these are not known, they must be determined as described in Detector HV Selection (page 9-4) before proceeding with the calibration. The iPCM12 is then ready for calibration.

Calibration

Ensure the background is stable and any calibration sources are well away from the iPCM12.

1. Ensure the portal is empty and the unit is on and ready.
2. Login to the Administration mode, using the Health Physicist role (see Gaining Access to the Administration Mode (page 5-4)).

See Cal Check (page 5-34) for more information.

To check the calibration, the *Cal Check* button is selected. This does not allow the calibration factor to be changed, but a comparison is made between the old and new factor.

To recalibrate the instrument, i.e. adjust the calibration factor for a particular nuclide, the *Calibrate* button is selected.

The calibration process should be repeated for a number of nuclides that would be found in typical contamination. As a minimum, a calibration to an alpha emitter (^{241}Am) and a beta emitter (^{36}Cl) should be undertaken.

At the end of the calibration, the user is prompted to PASS or FAIL the calibration. See Specification (page 3-1) for more information regarding the various iPCM12 types.

NOTES: If the efficiency is very different from the expected value and the background is stable, perform an HV scan (see Performing the HV Scan (page 9-5)***) and repeat this procedure.***

The Instrument Configuration Report (See Reports (page 5-50)***) will provide a hard copy of the set-up and calibration results.***

Calibration for Other Nuclides

See HV Scan (page 5-41) for more information.

Efficiency factors for other nuclides and mixtures of nuclides can be defined in a similar manner to that for ^{60}Co described in Preparation for Calibration (page 10-2.)Before calculating efficiency factors for new nuclides, it would be advisable to verify those for ^{36}Cl, ensuring that the iPCM12's detectors are functioning correctly.

If low energy nuclides need to be monitored such as ^{14}C, then it may be necessary to undertake an HV scan for that particular nuclide. Follow the procedure described in Performing the HV Scan (page 9-5), specifically for the Figure of Merit method (see Figure of Merit (FOM) method for gamma scintillation detectors (page 9-8)), in order to find the best operating voltage.

Calibration mixes

The iPCM12 will allow "calibration streams" to be set, which will include a number nuclides and their associated percentage in the mix. The iPCM12 will take account of the respective efficiency of the nuclide and the percentage, to evaluate the overall efficiency of the iPCM12 to the mix. Note that even when the iPCM12 is calibrated to a single nuclide, such as ^{36}Cl, this is still treated as a single nuclide stream. Only those nuclides to which the iPCM12 has been calibrated, may be included in the mix.

Calibration (page 5-15) and Cal Streams (page 5-40) shows how to create the mix for a new calibration stream.

It is not essential that the percentage of all the nuclides entered adds up to 100 %. In this situation, the iPCM12 will assume the unidentified percentage is due to undetectable nuclides, such as ^{55}Fe, and adjust the overall percentage efficiency to the mix appropriately.

Chapter 11 Maintenance and Trouble Shooting

Fault Messages

The fault messages produced whilst in the application are directly controlled by the software written by Thermo Fisher Scientific whereas errors reported from the motherboard Bios or the Window's operating system will be supplier dependent.

Power-up Screens

On switching ON the screen will remain blank for several seconds whilst the Bios carries out basic checks on the motherboard. The screen will eventually show scripting which details the progress of these initial tests. Should a fault be found, the process will halt with the fault/error detailed. This should be recorded and reported to Thermo Fisher Scientific's Service department. The equipment cannot be used until the fault is removed.

It must be noted that a failure of the LCD backlight module will leave the display blank even though "boot-up" is taking place correctly.

In a normal boot-up the Bios' sequence of tests will be followed by loading the operating system from the disk drive, signalled by the Thermo Fisher Scientific log screen. Any failure here will result in a "blue" screen. Again you will need to contact Thermo Fisher Scientific's service department if this does occur.

Finally the application software will be loaded and the iPCM12 User screen will be displayed.

Self Test Screens

The application is entered with tests to verify the detection components are working correctly. Should a failure occur during these initial checks then the "Out of Service" message will appear on the message bar and one of the following will be displayed on the message bar:

1. Unable to set detector alarms
2. Database Offline
3. Unable to Configure Detector Subsystem
4. Invalid Language Setting

5. Default Calibration has no Alarms
6. Configured Error
7. Failed to Retrieve Sound Data From Database
8. No Default Calibration Selected
9. X-Channel Failure
10. X-Channel Failure Accessing Node {0}, ID {1}

Device Error Messages

If one of these messages occurs, a fault with a peripheral device is indicated. Normal operation of the iPCM12 can be continued when action has been taken to rectify or circumvent the problem.

PRINTER NOT ACCEPTING DATA - The printer refused to accept data for over ten seconds. This may be due to the printer being disconnected, off-line or turned off. Check the printer and the connection to the iPCM12 (see Network Communications (page 3-9)).

Operational Self Tests

Whilst the iPCM12 is in Background Checking mode, certain aspects of the instrument's operation are tested repeatedly. If a fault is detected, the iPCM12 will display the appropriate message as follows:

1. Amplifier Failure
2. Amplifier Counter Failure
3. Amplifier Counter Overflow
4. Amplifier HV Over Current
5. Amplifier HV Over Voltage
6. Amplifier HV Under Current
7. Amplifier HV Under Voltage
8. Amplifier Dead Time Saturation
9. Amplifier EEPROM failure
10. Lamp Control Failure
11. X-Channel Failure
12. X-Channel Failure Node {0}

The fault messages produced whilst in the application will, typically, result in the "OUT of SERVICE" and "Critical Error" messages being displayed. Reference to OUT OF SERVICE (page 5-97)may assist to clear this fault and allow continued operation.

An extreme failure may result in the Window's "blue" screen halting further activity. This will require rebooting the

software. However, continued occurrence of this fault would suggest a serious problem that needs reporting to Thermo Fisher Scientific's service department.

Servicing of the Electronic Assemblies

The Electronic display chassis **D92520/A** contains the ETX processor 5712A, HV generator 5713A, DC/DC converter 5714B, Gas flow control chassis and LCD sub-assembly. They are all mounted on the steel chassis above the PSU module and battery controller and battery.

NOTE: AS A MATTER OF GENERAL ELECTRICAL SAFETY AND FOR CONTINUED EMC PERFORMANCE, ANY EARTH TAGS, WIRES, CONNECTORS OR COVERS REMOVED FROM ANY PART OF THE iPCM12 IN THE COURSE OF SERVICING, MUST BE REFITTED. CARE SHOULD BE TAKEN AT ALL TIMES NOT TO SHORT THE BATTERY TERMINALS.

Access to Electronic Chassis

NOTE: THERE ARE POTENTIALLY DANGEROUS VOLTAGES IN THIS COMPARTMENT ON THE HV GENERATOR MODULE, AND ON THE MAINS PSU MODULE. THESE ARE NORMALLY SCREENED

HOWEVER IT IS WISE TO SWITCH THE iPCM12 FRONT PANEL KEY TO 'OFF' AND THE INTERNAL MAINS UNIT ISOLATOR TO 'OFF' BEFORE DISCONNECTING ANY CABLES OR REMOVING CARDS.

!!!BUT REMEMBER THE BATTERIES ARE STILL CONNECTED!!!

To gain access to the Electronics display chassis components the iPCM12 right hand side panel must be unlocked and hinged open.

Removal of the Electronics Chassis from the Corner Frame

NOTE: Before commencing this operation, disconnect the two battery cables (B92059/A & 5659B) from the battery controller card found at the bottom left side chassis below the electronic display chassis.

Alternatively, see Battery - Removal and Replacement (page 11-7) for guidance.

When carrying out major Servicing work on the Electronic display chassis D92520/A, it may be advantageous to remove it from the iPCM12. The chassis is removed from the main frame as follows and since the assembly is complete, stand-alone testing is also possible.

The door panel stay will need to be un-hitched to allow access to the gas chassis at the top left hand corner. Before the main chassis can be removed, the gas chassis D92610/A must be removed first, by unscrewing 4 x M4 hex retaining studs. Disconnect the gas lines from the chassis – MAKE A NOTE of the gas links for later reconnection – if necessary refer to D92591 sheet 4 (see Drawings list (by assembly) (page 12-2)).

Disconnect the following *external* cables from the boards on the chassis:

1. PSU cables B92594/A & B92597/A
1. USB cable on SK4
2. Gas chassis cable 703025KF
3. X-channel: external yellow cables at SK4,6,7,13 & 14 (leaving only SK8 connected)
4. Lamp indicator cables B92596/A & B92165/A
5. Loud speaker cable 11705242
6. The network cable in SK201
7. 2 x HV (red) cables on 5713A generator module

The Electronics Chassis is now freed by removing the 10 x M6 hex retaining studs (M10 spanner required) securing the chassis to the panel.

Hold the assembly and lift out clear of the top left corner frame.

When refitting the Electronics display chassis into the top left corner frame, ensure:

- All the cards are securely screwed down.
- The ETX assembly and heat sink are correctly fixed.
- The disk drive cable is correctly fitted.
- All ten M6 fixing bolts are fitted and tightened.
- All cables are returned to their associated plugs/sockets connecting battery cables last – refer to D92591 sheet 1 as necessary.
- All earthing points are restored.
- Restore the cable harnesses to their original wrapped condition.

Removal and Replacement of the Power Supply

IMPORTANT: BEFORE ANY WORK STARTS ENSURE THAT THE MAINS SUPPLY IS DISCONNECTED FROM THE iPCM12 AND THE iPCM12 IS POWERED OFF AT THE FRONT PANEL KEYSWITCH.

Unlock the right hand iPCM12 side access panel. The mains PSU power supply for the iPCM12 is mounted in the lower left section of the main frame.

Having first disconnected the external mains supply on the iPCM12 top plinth locate the PSU assembly and switch the rocker switch to OFF. Unscrew the two screws retaining the rocker switch cover protective lid.

Remove the connections of cable B92261/A (supply input) and B92603/A (output) and the earth strap to the earth point. Unscrew 4 corner screws to extract the assembly for repair on the bench.

Power Supply Replacement

The Power Supply module contains dangerous high switching voltages and is not user serviceable. It should be returned to Thermo Fisher Scientific's service department for repair or replacement.

Ensure the correct type of replacement power supply is used (See Recommended Spares List (page 12-1)). Replacement of the Power Supply is the reverse of the removal procedure. If the Power Supply is thought to be faulty it should be replaced with an identical unit (See Recommended Spares List (page 12-1)). Replace the connections ensuring all the clamping screws are tight and all GROUND/EARTH connections are made. Ensure the rocker switch cover is replaced to protect the user from any high voltages.

Adjustment of PSU

There is no PSU adjustment.

Mains Inlet/Filter & Isolator

In the event of either part requiring replacement, it must be replaced with a unit of identical type. When re-connecting the mains wiring, ensure the mains inlet earth connection is made securely to the Central Earth Point (CEP). These requirements are mandatory and necessary for continued EMC performance and user safety.

Battery - Removal and Replacement

CARE SHOULD BE TAKEN AT ALL TIMES NOT TO SHORT THE BATTERY TERMINALS or DAMAGE THE FOOT DETECTOR WHILST THE FOOT TREAD PLATE IS REMOVED.

The battery is a sealed lead/acid jelly type construction and does not require regular maintenance. Batteries should be periodically tested for capacity and will probably need replacing after 3-4 years. If however, it requires replacement, proceed as follows:

1. Switch off the iPCM12 (keyswitch), switch off the PSU (Rocker switch); disconnect the external mains supply (top plinth). Disconnect battery cables from 5703A control board (PL5 & PL7).
2. Remove the angle bracket (two screws) covering the battery holder; remove the battery compartment top cover (four screws). Lift out metal brackets.
3. The battery may be tilted out to reveal the connecting cables.
4. Disconnect the thermistor assembly from the negative BLACK terminal marked '-', taking care not to short it to the '+' terminal.
5. Disconnect the red wire from the positive RED '+' terminal taking care not to short it to the terminal.
6. Remove the battery. Dispose of it safely as required. The battery should be replaced only with one of a similar type or operation of the iPCM12 may be impaired.

When refitting the battery, make sure the mounting bracket is properly secured. Reconnect the red wire to the RED + terminal first.

Reconnect the thermistor card to the BLACK - terminal last. Failure to do this may impair charging control and may lead to premature battery failure.

The battery contains hazardous substances; please take care to dispose of the old battery in accordance with your local regulations – in Europe Directive 2006/66/EC.

Hard Disk Drive Removal and Replacement

The Disk Drive is situated near the top of the Electronics Chassis.

Switch off the power and remove the electronic chassis as described in Removal of the Electronics Chassis from the Corner Frame (page 11-4).

The disk may be removed with the chassis in situ but care will be needed in refitting the holding screws**.**

Disconnect the ribbon cable 11705206, remove the four screws and washers securing the drive to its anti-vibration mounts. The disk is now free to be removed from the Electronics chassis.

Replacement of the Hard Disk

Replacement of the disk is the reverse of the removal procedure. Should the disk be thought to be faulty it should be replaced with an identical unit (See Recommended Spares List (page 12-1)) preloaded with all necessary software.

When the instrument is first started with the replacement disk, the application will signal "out of service" because of missing calibration data.

This data, which is held in flash memory (also found on the 5712A control board), needs to be transferred to the new disk by invoking the following procedure:

- Access the Administration Mode (see Gaining Access to the Administration Mode (page 5-4)). Select System and Exit to Administrator Logon.
- Insert a USB keyboard and LOG ON to Windows as Administrator (see Gaining Access to the Administration Mode (page 5-4)).
- RUN "Restore.bat" in C:\IPCM Database\scripts
- Log off Windows
- Log on to Windows as ThermoUser

Battery Controller Board Type 5703A - Removal and Replacement

Switch off iPCM12 using the keyswitch and remove the mains power supply.

The charger PCB is situated at the bottom of the Electronics Chassis.

Disconnect any cables, remove the four M3 hex screws and washers securing the PCB to its mounting spacers. The PCB is now free to be removed from the Electronics chassis.

Replacement of the Charger PCB

Replacement of the charger PCB is the reverse of the removal procedure (PL7 last). Should the Charger PCB be thought to be faulty it should be replaced with an identical unit (see Recommended Spares List (page 12-1)).

ETX processor Board type 5712A Removal and Replacement

Switch off the power and remove the electronic display chassis after disconnecting external cabling links, as listed in previous paragraphs .

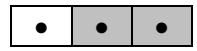
Remove all the screws retaining the PCB to their mounting spacers. Disconnect remaining internal cabling links at SK8, PL10, PL7, PL6 and PL2. The PCB can now be lifted away from the Electronics display chassis.

Replacement of the ETX processor board

Replacement of the Controller PCBs is the reverse of the removal procedure. If the main processor is thought to be faulty, it should be replaced with an identical unit (see Recommended Spares List (page 12-1)).

Remember to transfer the Flash memory from the old card to the new one as this contains all the necessary configuration data.

Set the Links on the 5712A as follows:



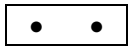
LK2

LK5

LK4

LK9

LK3



DC-DC Converter 5714A - Removal and Replacement

Switch off the power and power down the iPCM12. The 5714A is located below the ETX processor board and may be unscrewed (4 screws) and removed with/without removal of the Electronic display chassis from the left side frame.

Four cables need disconnecting: B92597/A, B92603/A, B91918/A & B92604/A.

Replacement of the DC-DC Converter board

Replacement of the 5714A is the reverse of the removal procedure. Should the converter thought to be faulty it should be replaced with an identical unit (see Recommended Spares List (page 12-1).

FHT681 cards (as used in gamma option iPCM12B & iPCM12C) - Removal and Replacement

WARNING: THE HV & AMPLIFIER PCB'S GENERATE DANGEROUS HIGH DC VOLTAGES. EXERCISE CAUTION WHEN SERVICING, ALWAYS ALLOW THE HV TO DISCHARGE BEFORE COMMENCING WORK.

The FHT681 cards (5 maximum) are mounted in pairs in the top section of the right side frame behind the lockable right hand side panel.

Labels on the panel identify how the cards connect with pairs of scintillation detectors and the address of the cards.

BEFORE ATTEMPTING TO REMOVE ANY FHT681 BOARD, SWITCH THE iPCM12 OFF AND WAIT 1 MINUTE FOR THE HV TO DISCHARGE BEFORE BEGINNING WORK.

To remove any assembly from the frame, unscrew the four front panels from the top righthand framework, and then carefully withdraw the amplifier card. Disconnect the rear two daisy changed ribbon cables (grey) that link the assembly to the ETX processor. [Note that all the FHT681's are connected via PL12 on 5712A].

Then release the front MHV coaxial cables from the HV & amps cards

Replacement of the FHT681HV-Amps

Replacement of any of the boards is the reverse of the removal procedure. Ensure the detector cables are matched to the correct amplifier connector as detailed on the enclosure label.

If any Board is thought to be faulty it should be returned to Thermo Fisher Scientific's service department for repair.

Replacement of any amplifier will require recording its serial number on the relevant enclosure label and informing the software of this new address.

NOTE: All cards MUST be linked up using the rear ribbon cables (grey) originally supplied

Changing the FHT681 Address

Since removal of any card will have produced an X-Channel error, the user will need to log-out, insert the administrator **Dongle**, and log on as Administrator (see Gaining Access to the Administration Mode (page 5-4)).

You will need to connect a USB keyboard to carry this out:

1. Select the shortcut to "DevConfig".
2. Select "Load Devices" and highlight the removed card's address.
3. Select "Change Address" to retype the new serial number.
4. Press "OK" to register and "Save" to store as the new address.
5. Exit this routine and log on as Thermo User again.

Setting the FHT681 Current Limits

When an amplifier card is exchanged, it will be necessary to check the Min and Max current levels for each detector are set at "50" and "200" respectively using the HV Scan (page 5-41) facility. They will need resetting, if they are still set to "0" and "255", using the same facility.

When these values are correctly set the application will be able to report any detector disconnection or light leak.

LCD Display, Touch Screen, Touch Controller & Backlight Inverter - *Removal and Replacement*

WARNING: The Backlight Inverter generates dangerous high voltages. Exercise caution when servicing, always allow the HV to discharge before commencing work. Do not remove the Inverter from its protective screening enclosure.

Refer to assembly drawing D92563/A for details.

Switch off the power. Ensure the iPCM12 is OFF.

1. It is preferable to remove the whole Electronics display assembly to gain straightforward access to the LCD subsystem.
2. Remove the four hex pillar screws from the rear of the display housing and remove the ETX processor board 5712A . Undo the back-plate.
3. The back-light and Touch-screen controller cards lie beneath removable protection covers on the back of the display.
4. Take care in removing the connecting cables.

Both the Touch Controller module and the Back-light Inverter are propriety items and are not user serviceable. They should be returned to Thermo Fisher Scientific's service department for repair or replacement.

1. To remove the LCD display, disconnect all cables (3).
2. Undo the display retaining screws located round the periphery of the metalwork.
3. Gently pull the front bezel assembly away from the main housing and lay carefully onto a flat surface.
4. Four screws attach the LCD shield to the front bezel.
5. On removal the LCD and shield can be lifted from the bezel and touch screen, itself sitting in a recess of the plastic bezel.
6. The touch screen is not fixed to the bezel. Another four screws hold the aluminium shield to the LCD, via spacers.

Replacement of the LCD Display, Touch Screen, Touch Controller and Backlight Inverter

Replacement of the LCD Display, Touch Screen, Touch Controller and Back-light Inverter is the reverse of the removal procedure. Should any item be thought faulty they should be replaced with an identical unit (See Recommended Spares List (page 12-1)).

It is necessary to take special care in handling the Touch Screen and LCD, to keep all faces free of dirt and finger marks!

Display guidance 5711A and LED cluster board 5672A- *Removal & Replacement*

The 5711A is located at the left inner side of the iPCM12 at user chest/head height.

The outer label must initially be prised off the face of the display to gain access to the 6 countersunk fixing screws. After removal the display may be eased forward and the 6 way coloured ribbon cable B92596/A disconnected. DO NOT allow the cable to fall back inside the housing; firmly tape the cable for future reconnection.

The 5672A LED cluster is located on the top plinth front face of the iPCM12, or optionally on the right hand face, depending on the site configuration/requirement. The board may be removed by unscrewing 6 M3 hex pillars on the rear panelling and disconnecting the 6 way coloured ribbon cable. There is no need to remove the front labelling.

The LED's are propriety items and therefore are not user serviceable. The 5711A display label will need to be replaced with a new label B92433 after the board has been refitted. The boards should be replaced with identical parts as detailed in Recommended Spares List (page 12-1).

Sensor Assemblies - *Removal & Replacement*

The sensor assemblies are connected to the detector 5704A Quad Amp boards via PL4 (TX) and PL3 (RX), and communication is via the X channel internal network to the 5712A ETX processor.

Various sensor housings are fitted, although the infrared TX and RX components are identical 702260ND. The sensor locations and cabling is as shown on interconnection diagram D92591 sheet 6, and the sensor housings are listed on the iPCM12A family tree D92525.

Individual sensor assemblies may be removed by unscrewing two M3 countersunk screws, unwiring the sensor leads and unplugging the ribbon cable(s).

The sensors are propriety items and therefore are not user serviceable. They should be replaced with identical parts as listed on the family tree D92525. Active RX/TX sensors are detailed in Recommended Spares List (page 12-1).

Replacement of the Sensor Assemblies

After renewal, connect the individual sensor wiring as indicated on D92591 sheet 6 and remount using two M3 countersunk screws.

Gas flow detector - Removal and Replacement

All variants of iPCM12 contain gas flow detectors type 5710A. The front face of these detectors is a conductive sheet of gas tight mylar/melinex sheeting, which is easy to puncture. Handle the detectors only from the sides and rear, and do not place the detectors face down on a rough surface.

Disconnect the mains supply and switch off the iPCM12 using the keyswitch.

Array Detectors (12), Top of Foot Detector (1)

1. Unlock the array detector panelling, and hinge the detector arrays outward to the left hand side. Clear access to the Top of foot detector is also provided.
2. Disconnect the HT lead (red) , network cables (yellow) and any sensor wiring (red/black).
3. Using the blue Festo test tubing, bypass the gas circuit of the 5710A detector. Alternatively utilize the “Hot spare” detector.
4. Unfasten earthing straps.
5. Each detector is retained with two Velcro straps which must be released when withdrawing the detector. Replace detector with “Hot spare” if required.

Island Doors Leg Detectors (2)

1. Unlock the detector paneling, and hinge the detector arrays outward to the left hand side.
2. Disconnect the HT lead (red) , network cables (yellow) and sensor wiring (red/black).
3. Using the blue Festo test tubing, bypass the gas circuit of the 5710A detector. Alternatively utilize the “Hot spare” detector.
4. Unfasten earthing straps.
5. Each detector is retained with two Velcro straps which must be released when withdrawing the detector. Replace detector with “Hot spare” if required.

Shoulder, Side of Head, Inner & Outer Hand Detectors (4)

These are accessible via the right hand service panel and the island door.

A bracket retains the Outer Hand detector, so unscrew the knurled nuts and remove this bracket before lifting out the detector.

All the other detectors are held in place only by the Velcro straps.

For removal proceed as previously:

1. Disconnect the HT lead (red) , network cables (yellow) and any sensor wiring (red/black).
2. Using the blue Festo test tubing, bypass the gas circuit of the 5710A detector. Alternatively utilize the “Hot spare” detector.
3. Unfasten earthing straps.
4. Each detector is retained with two Velcro straps which must be released when withdrawing the detector. Replace detector with “Hot spare” if required.

Side of Foot Detector (1)

This is accessible via the right hand service panel and the island door.

Two small brackets retain this detector. Unscrew the knurled nuts holding the brackets and withdraw the detector via the inner

For removal proceed as previously:

1. Disconnect the HT lead (red) and network cables (yellow).
2. Using the blue Festo test tubing, bypass the gas circuit of the 5710A detector. Alternatively utilize the “Hot spare” detector.
3. Unfasten earthing straps.
4. Each detector is retained with two Velcro straps which must be released when withdrawing the detector. Replace detector with “Hot spare” if required.

Overhead Detector

This is located facing downwards in the overhead plinth. It is retained only by Velcro.

For removal proceed as previously:

1. Disconnect the HT lead (red) and network cables (yellow)
2. Using the blue Festo test tubing, bypass the gas circuit of the 5710A detector. Alternatively utilize the "Hot spare" detector.
3. Unfasten earthing straps.
4. Each detector is retained with two Velcro straps which must be released when withdrawing the detector. Replace detector with "Hot spare" if required.

Foot Detectors (2)

Open outwards the array detector panelling to gain clear access to the foot plinth. Unscrew two countersunk screws on the plastic retainer, and lift this off over the toe sensor pod.

Lift out each foot detector for servicing:

1. Disconnect the HT lead (red) , network cables (yellow) and sensor wiring (red/black/blue).
2. Using the blue Festo test tubing, bypass the gas circuit of the 5710A detector. Alternatively utilize the "Hot spare" detector.
3. Each detector is retained with two Velcro straps which must be released when withdrawing the detector. Replace detector with "Hot spare" if required.

Repairing Gas Flow Detectors with Leaks

Lay the defective detector on a flat work surface so that the window is uppermost.

Unscrew 14 countersunk screws retaining the window, replace with new window B92412/A, carefully position over O ring and replace all screws in the outer grille.

Connect the detector to the spare or test output of the gas chassis and purge the detector prior to re-use.

Restart iPCM12 ensuring that the iPCM12 Dongle is placed in the USB connection. Reselect NODE address of detector if the "Hot spare" has been used. [This requires the iPCM12 to automatically reboot, and by selecting "Setup" and "Xchannel" the new HP address of the detector can be identified and enabled on screen.]

Scintillation Detector Removal and Replacement

This section only applies for iPCM12B and iPCM12C when fitted with the gamma option kit AE0222A

NOTE: The detectors are light sensitive and, because of this, are contained in a light-tight enclosure. Care must be exercised at all times not to damage the enclosure as subsequent damage to the photomultiplier tube may result due to light leaks.

Removal

CAUTION: TO AVOID LEAD CONTAMINATION, THE LEAD PIECES SHOULD BE HANDLED WITH GLOVES. WASH HANDS AFTER HANDLING. REFER TO THE MATERIAL SAFETY DATA SHEET THAT ACCOMPANIES THE LEAD.

LEAD IS AN EXTREMELY DENSE MATERIAL. SOME OF THE LARGE PIECES OF SHIELDING WEIGH UP TO 35 KGS. USE CORRECT HANDLING PROCEDURES TO AVOID PERSONAL INJURY.

Disconnect the mains supply. Ensure the iPCM12 is switched OFF.

Body Gamma Detectors (6)

1. Unlock the array panel and hinge outwards to reveal the body detectors.
2. Carefully remove Velcro straps.

CAUTION: Each 5717A detector weighs about 10kg.

1. Before lifting out the detector, disconnect MHV coaxial cable.

TAKE CARE THAT THE DETECTORS DO NOT FALL!!

Overhead Detector (1)

1. Remove the lid panel to reveal the head detector.
2. Remove the two lead panels sitting on the detector.
3. Disconnect the MHV coaxial cable.
4. Carefully withdraw the 5708A detector.

Foot Detector (1)

1. Open outwards the array detector panelling to gain clear access to the foot plinth. Unscrew two countersunk screws on the plastic retainer, and lift this off over the toe sensor pod.
   - Remove the two Velcro straps.
   - Disconnect the MHV coaxial cable.
   - Carefully lift out the 5708A detector.

Hand Detector (1)

1. Open the right hand iPCM12 service access panel to reveal the hand detector fitted to the inside door panelling.
2. Disconnect the MHV coaxial cable.
3. Remove the detector support housing (six M4 nuts).
4. Carefully lift out the 5708A detector.

TAKE CARE THAT THE DETECTOR DOES NOT FALL!!

Detector Replacement

Replacement of the Detectors follows the removal procedure in reverse. Again care must be exercised not to break the light-tight seals.

Once the detectors are in place, refit all spacers, straps and panels .

Setting up Replacement Detectors for Use

Replacement detectors or detectors with replacement PMT's will need to be set for optimum performance with the Isotopes of interest. Before determining HV's, the Single Channel Analyser Thresholds must be reset to their default settings or erroneous results will be obtained (see Thresholds (page 5-47)). Once this is done, select the detector operating point using the HV scan procedure detailed in Selection of Detector Operating Parameters (page 9-4).

iPCM12C GPIO (5707A)

This section only applies for iPCM12B and iPCM12C when fitted with doors, inlet barrier or turnstile controls.

Disconnect the mains supply and switch the iPCM12 OFF.

This interface unit is housed on the left side next to the HV generator module The board can be removed from the chassis by unscrewing the M3 hex studs and disconnecting all the control cables and the Xchannel network cable (yellow).

GPIO Replacement

The replacement follows the removal in reverse. Ensure the connectors are correctly mated.

iPCM12C Barrier Arm and Motor

NOTE: Whilst the motor actuator has a protective clutch to limit the impact force on any obstacle it is prudent to be aware of its "field of play".

Again, work on the unit with the iPCM12 OFF.

The barrier arm can be replaced by undoing the three retaining bolts that secure it to the motor assembly.

The motor is accessed by removing the four corner panel retaining bolts revealed by unlocking the relevant detector cover. The barrier arm will need removing, as will the motor flange (visible from the outside of the corner panel) by removing the central fixing screw.

Removal of the motor is possible after undoing the two nyloc nuts (rear of motor) holding the drive to the holding plate that is secured to the panel work. The attached cable can be unplugged locally to allow complete removal of the motor.

Barrier Replacement

Replacement of the Barrier motor and/arm follows the removal procedure in reverse.

iPCM12C Powered Doors

There are no user serviceable items on this unit. Please contact Thermo Fisher Scientific service department for support.

Troubleshooting (Operational)

This Section covers a number of possible operational problems, their likely causes and possible remedial action.

WARNING: EXERCISE EXTREME CAUTION WHEN SERVICING.

There are dangerous mains voltages around the power supply module and very dangerous high voltages on the HV and amplifier boards. High voltage also exists on the LCD backlight and in the inverter enclosure. The 12 v battery stores considerable energy, so care should be taken not to short the terminals. Please read the cautionary notes in Servicing of the Electronic Assemblies (page 11-3).

Normal Start-up (Boot-up) Operation

In general a successful start, or "boot up" when the iPCM12 key-switch is turned is indicated by:

- a series of "System Self Test" display messages
- a series of lamp tests , each accompanied by a "beep" tone
- a series of internal (invisible) self tests
- a single chime "ding-dong" on satisfactory completion

Unit "dead" (will not boot up) & charging LED is OFF

If the display remains blank and unlit, no lamps are lit and no sound is heard (assuming the volume has not been turned off) it would indicate that the iPCM12 is "dead".

LED OFF - indicates the AC mains supply is OFF and instrument cannot run off the battery.

1. Check the fuse on the 5703A charger PCB, F1 (6.3Amp).
2. If the fuse is intact, the battery is probably discharged. Check the voltage at PL7 on the charger PCB. If it is below 11.2 volts, the battery is discharged and the charging supply must be restored before further operation is possible.

Restoring the AC mains/charging supply - should light the LED and allow the system to run while charging the battery.

1. Check the AC mains power cord is connected (at the top face of the plinth).
2. Check the fuse in the mains adapter (if fitted).
3. Check that rocker switch is ON and power supply is receiving the mains supply.
4. Check the power supply output on 5703A PL1 (temporarily remove from pcb to check) - no output indicates the internal fuse has blown and the power supply should be replaced (see Removal and Replacement of the Power Supply (page 11-6)).
5. Check the output on PL7 of the 5703A charger PCB - it should be greater than +12.5 volts.

Unit "dead" (will not boot up) & charging LED is ON

Front panel LED **ON** - indicates that AC mains supply is ON and should be powering the instrument while charging the battery.

1. Retry switching the unit ON.
2. Check the fuse on the 5703A charger PCB, F1.
3. Check the battery voltage is greater than 12.5 volts.
4. Check there is battery voltage on OUTPUT connector PL4. If no output is observed on PL4, a fault on the charger PCB is indicated and it should be replaced as detailed in Replacement of the Charger PCB (page 11-9).
5. Check the power connections from the 5703A Charger PCB to the 5714A board and 5712A.
6. Check the regulated +12 V, -12 V & +5 V outputs from the DC-DC converter module 5714A. The DC-DC module is not user serviceable and if faulty the Converter board should be replaced. Switch iPCM12 unit OFF and replace the 5714A Controller board.
7. If the iPCM12 is still faulty, change the ETX processor board type 5712A, referring to ETX processor Board type 5712A Removal and Replacement (page 11-10).
8. If the iPCM12 is still dead after changing the 5714A controller and 5712A processor boards, contact Thermo Fisher Service department for further help.

Starts-up but Display is "Blank" & Fails Self Tests (no chimes)

If the iPCM12 starts but fails to chime ("ding-dong") within 60 seconds of being switched ON, then it has not successfully completed the power-on Self Tests and a fault is indicated. Observe the LCD display, if a fault message is displayed refer to subsequent subsections. If, however, the display is blank or the message is unintelligible, it is likely the ETX processor board has a serious fault and the microprocessor has I/O problems or has crashed. Replace the processor board as described in ETX processor Board type 5712A Removal and Replacement (page 11-10).

Will not run & displays "Out Of Service – Low Background Counts"

The blue FAULT lamp is lit (see Fault Messages (page 11-1))for an explanation of the fault messages). The Self Tests have detected the background count from the detector channel is below the Low Background Limit value set in Monitoring (page 5-12). Proceed as follows:

1. Enter a valid password and Setup |Monitoring (page 5-12). Check that the Low Background Limit is not set to an unreasonably high value for the prevailing background condition.
2. Select Calibration| HV Scan (page 5-41) and check the HV settings for each channel are correct. It may be necessary to refer to the original manufacturing configuration print-out, or to the commissioning configuration print-out for the iPCM12.
3. Check the cable connections between the 5712A processor board and the HV & Amplifier pcbs (at PL12) and the X channel network cables SK1,6,7,8,13 & 14.
4. Check HV cables (red) to faulty gas flow detectors 5710A and 5713A HC generator.
5. Having performed checks 1 to 4 above, select Diagnostics|Detectors (page 3-4), perform a 10 second count and check the faulty channel/s and note the counts.

Zero counts in a channel usually implies a complete failure in either the 5710A detector or HV/Amplifier PCB. A few counts suggests either reduced detector efficiency or threshold problems in a gas flow amplifier or HV/Amplifier.

1. Swap the gas flow HV cable to a working channel if possible. Perform a further 10 second count and note the counts in each channel.
2. If the fault moves with the detector into a previously working channel, the fault is in the detector cable assembly and should be replaced.

3. If the fault remains with the original gas flow channel, the fault is in the 5710A counter and this should be replaced, using the pre-gassed “hot spare” if available.
4. For iPCM12C gamma options swap the faulty scintillation detector MHV connection from the relevant HV/Amplifier to that of a working channel. Perform a further 10 second count and note the counts in each channel.
5. If the fault moves with the detector into a previously working channel, the fault is in the detector assembly and should be replaced as defined in FHT681 cards (as used in gamma option iPCM12B & iPCM12C) - Removal and Replacement (page 11-11).
6. If the fault remains with the original HV/Amplifier channel, the fault is in the HV & Amplifier PCB and this should be replaced as defined in FHT681 cards (as used in gamma option iPCM12B & iPCM12C) - Removal and Replacement (page 11-11).

Will Not Run & Displays "Out Of Service – High Background Conditions"

This condition occurs when the Background activity prevents the iPCM12 from discriminating the pre-set alarm levels (α and β for gas flow detectors, and γ for gamma option) with the required confidence within the Maximum Monitoring Time allowed. It may be necessary to consult Health Physics for clarification.

Enter a valid password and proceed as follows:

1. Select Setup |Monitoring (page 5-12) and check the Maximum Monitoring Times are set to reasonable values. Adjust upwards if necessary.
2. Select Setup |Alarms (page 5-18) and check the Normal Alarm levels are set to reasonable values. Adjust upwards if necessary.
3. Select Setup |Detection Options (page 5-16) and check the Probability of False Alarm is set to a reasonable value. Typically 3.1σ. Reduce it if necessary.
4. Select Setup |Detection Options (page 5-16) and check the Probability of Detection is set to a reasonable value. Typically 1.65σ. Reduce it if necessary.
5. Select Calibration HV Scan (page 5-41). Check that the High Voltage setting for the gas flow detectors (α and β selection) is correct – typically 1700V for P7.5 Argon/Methane gas. For gamma detectors (γ selection) if fitted, check that High Voltage settings of ALL eight detector channels are correct – typically ranging from 800V to 1100V.

6. Select Setup |Monitoring (page 5-12) and set a 10 second Minimum Monitoring Time. Check the counts in all gas flow detector channels and all scintillator channels are reasonable for the expected ambient background level using Diagnostics|Detectors (page 3-4).
7. If a single channel shows a background count significantly greater than the other detectors, a noisy channel (or a scintillator light leak) is likely. Proceed as follows:
   - Swap the faulty gas flow detector for the pre-gassed "hot spare". It will be necessary to enable the replacement detector node/address (α / β) – see XChannel (page 5-19).
   - Swap the faulty scintillation detector MHV connection from the relevant HV/Amplifier to that of a working channel. Perform a further 10 second count and note the counts in each channel. *(N.B. Bear in mind the different operating voltages).*
   - If the scintillator fault moves with the detector into a previously working channel, the fault is in the detector assembly and should be replaced as defined in **Error! Reference source not found.** (page **Error! Bookmark not defined.**).
8. If the scintillator fault remains with the original HV/Amplifier channel, the fault is in the HV and Amplifier PCB and this should be replaced as defined in FHT681 cards (as used in gamma option iPCM12B & iPCM12C) - Removal and Replacement (page 11-11).
9. If all channels show a background count significantly greater than that expected, the iPCM12 is experiencing an elevated background. Proceed as follows:
   - Check the area immediately around the iPCM12 for sources of any possible contamination.
   - Measure the ambient background level with a suitable survey monitor. If the background is high, it must be reduced or the iPCM12 moved for normal monitoring operation to resume.

IF THIS CONDITION PERSISTS and the background and measurement limits seem to be reasonable, 'frisk' inside the monitor cubicle for a possible build-up of contamination.

Fails Lamp or LED Tests

A power-on Self Test lights each lamp & LED in turn. If any lamp or LED fails to light in sequence (except the charging LED), proceed as follows - using Diagnostics|Lamps (page 3-8)to re-test lamps as required:

1. Check the connections to the lamp assemblies and to the 5712A processor board.
2. Any device failure will need a replacement board.
3. If there are two lamp assemblies and neither are functioning, then a fault on the processor board is indicated and it should be replaced as described in ETX processor Board type 5712A Removal and Replacement (page 11-10).

Fails Loudspeaker Test

A power-on self Test produces a single chime "ding-dong" upon satisfactory completion. If no sound is heard, proceed as follows:

1. Enter a valid password and select System|Setup (page 5-62), and increase the volume. The speaker should produce a series of "beeps" which gradually get louder or quieter when the volume control is dragged.
2. If no sound is heard, check the speaker connection to the processor board.
3. Since the speaker is unlikely to have failed, a fault on the Controller board is indicated and it should be replaced as described in ETX processor Board type 5712A Removal and Replacement (page 11-10).

Fails the LCD Display Test

A power-on self Test switches on the back-light and produces series of "Self Test Messages and "beeps". If the display fails to show any message, or is totally "blacked out" proceed as follows:

1. Check the multi-cable connections from the display to PL6 & PL7on the processor board 5712A.
2. If check 1 above has not revealed the problem, a fault in the LCD module or Controller board 5691A is indicated.
3. Temporarily connect a spare LCD module to the Controller board PL6 & PL7 (the back-light is required).

If the message becomes visible, the fault is in the LCD display module. This is not user serviceable and should be replaced (with the back-light) as described in LCD Display, Touch Screen, Touch Controller & Backlight Inverter - Removal and Replacement (page 11-13).

If no message appears, the fault is in the processor board, which should be replaced as described in ETX processor Board type 5712A Removal and Replacement (page 11-10).

Display Backlight Failure

A power-on self Test switches on the back-light and produces a series of "Self Test Messages" and "beeps". If the back-light fails to light, proceed as follows:

1. Check the cabling from the back-light inverter enclosure to PL7 on the processor board.

Check that 5 volts appears across the pins of PL7 when the back-light should be on. If 5 volts is apparent then a fault in the LCD or back-light inverter is indicated. These items are not user serviceable and should be replaced as described in LCD Display, Touch Screen, Touch Controller & Backlight Inverter - Removal and Replacement (page 11-13). If the voltage is absent across the pins of PL7, a fault on the Controller board is indicated and it should be replaced as described in ETX processor Board type 5712A Removal and Replacement (page 11-10).

Will Not Accept Valid Passwords

If the iPCM12 starts and runs but will not accept a valid password, a fault is indicated either in the LCD Touch-pad or the Controller board. Proceed to LCD Keypad Inoperative or Not Aligned (page 11-27).

LCD Keypad Inoperative or Not Aligned

If the iPCM12 starts and runs but will not respond to password entry or returns incorrect characters on the LCD display, a fault is likely in the processor board or possibly the touch keypad. Proceed as follows:

1. Check the cable connections between the Touch screen keypad and the processor board. If uncertain try a replacement cable to isolate fault.
2. Similarly check the touch control board by replacement.
3. If unsuccessful, temporarily plug a spare LCD assembly into the control board. If this solves the problem the original Touch-pad is faulty and should be replaced as described in LCD Display, Touch Screen, Touch Controller & Backlight Inverter - Removal and Replacement (page 11-13).

4. If the problem still persists the fault is likely to be in the 5712A board which should be replaced as described in Replacement of the ETX processor board (page 11-10).

Will not Enter Background Mode Or Locked in Background Mode

If, after power-up, or after exiting from the main menu, the iPCM12 displays "Cannot Measure Background - Please Exit the Portal", a fault with the Infra Red links is likely. Proceed as follows:

1. Check that the Links are working correctly by selecting "Diagnostics/Sensor". The switch and links can be tested for correct operation.
2. Check the continuity of the cable connecting the Sensor(s) to the adjacent 5710A detector boards.

Replace the processor board as described in ETX processor Board type 5712A Removal and Replacement (page 11-10) if the switches are working correctly.

Locked in Measurement Mode

If the iPCM12 becomes stuck in a monitoring cycle with the display showing "Count Time Remaining xx seconds" it is likely that microprocessor has crashed. Power down and check again. Continual crashing may indicate that the processor board needs replacing as described in ETX processor Board type 5712A Removal and Replacement (page 11-10). It is possible that the hard disk may have suffered some damage in this area of the program. If the problem persists even after changing the processor board a new disk should be considered.

USB Output Data is Corrupted

If USB data output from the iPCM12 to a serial printer, or external computer, contains spurious characters, or is corrupted in any way, check the following possible causes:

1. If no output whatsoever is received, check the data cable connections (see Displays (page 3-7)).
2. If a USB printer is involved, perform a printer self-test, to determine whether the printer itself is at fault.

The following section applies to iPCM12C with door/barrier options only.

Barriers will not OPEN/ CLOSE - Unreliable Door Operations

If the entry Barrier fails to Close UP or DOWN, then select the Diagnostic/Barriers (page 5-22) function to exercise the arm. Should this be successful, then check that the front barrier has been Enabled and Closed for one of the three options.

If un-successful, then it will be necessary to verify that power is reaching the motor by examining the voltages on the motor connector when it is asked to close/open (see Barriers (page 5-22)). If power exists, the motor assembly needs examining to decide whether the motor itself is at fault or the integral microswitches are damaged/ misaligned.

If no problem is found with the motor assembly and its cabling, then suspect the GPIO card. Replacing the 5707A should resolve the fault.

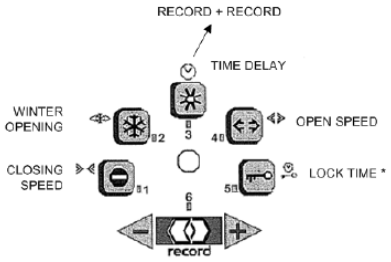
If the Powered Doors malfunction, then use Diagnostic/Barriers (page 5-22) function to exercise the doors. Should this be successful, then check that the rear doors have been enabled.

If unsuccessful, then it will be necessary to exercise the doors via the integral controller found in the upper section of the door control attached to the upper iPCM12 frame. See Appendix A Automatic Folding Door System, section Functions of electronic BDE-E9.2 for key functions panel (reproduced below):

1st level (operating modes)

Key functions:

- One-way operation
- Winter mode
- Automatic mode
- Continuously open
- Locked
- Programming
- Programming increment down
- Programming increment up



In the normal state, one LED should be lit.

CLOSED *or* *OPEN*

If this is not the case and a LED is flashing, then please refer to Appendix A Automatic Folding Door System, section Status and Fault Signals to identify the fault mode. Thermo Fisher Scientific Service department will need to be contacted for assistance.

If the LED correctly registers the status of the door, e.g. OPEN, then pressing the Close button will close the door and illuminate the closed LED. If this is correctly happening, then suspect a problem with the GPIO (5707A) card and its interconnection cables.

IT IS IMPORTANT THAT THE USER LEAVES THE DOOR IN A CLOSED POSITION, THE CONTROL PANEL OR OPERATION FROM THE iPCM12 APPLICATION WILL BE INHIBITED. SIMILARLY, IF IN DIAGNOSTICS AND THE DOOR IS OPENED, OPERATION FROM THE CONTROL PANEL IS RESTRICTED.

Chapter 12 Recommended Spares List

The following spares are recommended on the basis that **first-line service** is best performed on iPCM12A by changing modules:-

ETX CONTROLLER BOARD	5712A
DC/DC CONVERTER BOARD	5714B
QUAD GAS FLOW DETECTOR	5710A
ETX PROCESSOR	702964PB
SECURITY DONGLE	A92169/D
BATTERY CONTROLLER BOARD	5703A
GAS FLOW CONTROL BOARD	5709A
TOUCH SCREEN	702633ND
TOUCH-SCREEN CONTROLLER	702632ND
BACK-LIGHT INVERTER	702549ND
PWR MODULE 150W	702947KJ
KEYSWITCH	11705234
GUIDANCE DISPLAY BOARD	5711A
PHOTOSENSOR RX/TX PAIR	702260ND
5 WAY LED CLUSTER BOARD	5672A
PANEL LOCK & KEY	A92452

Spares list – basic components (iPCM12A)

ETX CONTROLLER BOARD	5712A
GAS FLOW CONTROL BOARD	5709A
DC-DC CONVERTER	5714B
ETX PROCESSOR	702964PB
REPLACEMENT HDD + OPERATING SYSTEM	A92083/A
5-WAY LED CLUSTER	5672A
GUIDANCE DISPLAY	5711A
BATTERY CONTROLLER BOARD	5703A
BATTERY TEMPERATURE SENSOR	5659B
HV GENERATOR BOARD	5713A
QUAD GAS FLOW DETECTOR	5710A
QUAD GAS PROPORTIONAL AMP BOARD	5704A
PHOTOSENSOR RX/TX PAIR	702260ND
GUIDANCE DISPLAY BOARD	5711A
5 WAY LED CLUSTER BOARD	5672A
SECURITY DONGLE	A92169/D

PANEL LOCK & KEY	A92452
SEALED BATTERY	503073KJ
LOUDSPEAKER	11705242
PWR MODULE 150W	702947KJ
12.1" TFT LCD	702548ND
BACKLIGHT INVERTER	702549ND
COMPACT FLASH	702275KM
TOUCH-SCREEN CONTROLLER	702632ND
TOUCH SCREEN	702633ND
HEX TREADPLATE	C92479
KEYSWITCH	11705234

Spares list – optional components

iPCM12B or C with gamma option only	HV & AMPLIFIER BOARD (FHT681)	425430223
iPCM12B or C with gamma option only	HAND, FOOT, SHOULDER SCINTILLATION DETECTOR	5708A
iPCM12B or C with gamma option only	BODY SCINTILLATION DETECTOR	5717A
iPCM12C only	GPIO CARD	5707A
iPCM12B or C with gamma option only	DYNODE CHAIN	A3/54040
iPCM12B or C with gamma option only	PHOTOMULTIPLIER TUBE	B35246

Drawings list (by assembly)

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5713A	HV GENERATOR	E92359/A
5659B	TEMPERATURE SENSOR BRD	C91794/B
5703A	BATTERY CONTROLLER BRD	D92313/A
5672A	5-WAY LED CLUSTER	D91956/A
5714B	DC-DC CONVERTER BOARD	C92356/A
	ETX PROCESSOR ASSEMBLY	D92615/A
5712A	ETX PROCESSOR BOARD	E92353/A
	GAS CONTROL CHASSIS	D92610/A

5709A	GAS FLOW BOARD	E96362/A
5711A	GUIDANCE DISPLAY BOARD	C92349/A
5707A	iPCM12C GPIO CARD	E92343/A
5710A	QUAD GAS FLOW DETECTOR ASSEMBLY	D92413/A
	iPCM12A INTERCONNECTION DIAGRAM *(See diagrams at back of document)*	D92591 [6 sheets]
	iPCM12 SCHEMATIC FUNCTIONAL DRAWING	Block diagram
	iPCM12A GENERAL ASSEMBLY DRAWING	D92590/A
	iPCM12B INTERCONNECTION DIAGRAM	D92777
	iPCM12B GENERAL ASSEMBLY DRAWING	D92767/A

Accessories list

CALIBRATION JIG ALPHA (^{241}Am) – 2 SOURCES	Details on request
CALIBRATION JIG BETA (^{36}Cl) – 2 SOURCES	Details on request
CALIBRATION JIG GAMMA (^{137}Cs)	Details on request
CALIBRATION JIG GAMMA (^{60}Co)	Details on request
SECURITY DONGLE	A92169/D
GAS FLOW SIDE OF FOOT KIT	AE0221A
GAS FLOW HEAD DETECTOR KIT	AE0223A
SCINTILLATION HEAD DETECTOR KIT	AE0224A
SCINTILLATION P.I.M. KIT	AE0225A
GAMMA SCINTILLATION DETECTOR KIT	AE0222A
SPARE PURGED DETECTOR KIT	AE0229A
ENCLOSED CABINET INLET BARRIER KIT	AE0237A
ENCLOSED CABINET DOOR LH/RH KIT	AE0238A
ENCLOSED CABINET LH SWING DOOR KIT	AE0239A
ENCLOSED CABINET RH SWING DOOR KIT	AE0240A
CAMERA KIT	AE0227A
USB PRINTER (EPSON LX300+)	Details on request
USB BARCODE READER	Details on request

Chapter 13 Glossary of Terms

µCi	micro-curie
A	Attenuation Factor or amps
Beff	Effective Background while Monitoring
Bq	Becquerel
Bsum	Total Average Background Count Rate
C	Counter(s)
CAct	Contamination Alarm Level
CCM	Cobalt Coincidence Monitoring
Ccps	Contamination Alarm Count-rate
Ceffect	Effective Alarm Count rate
Ci	Curie
CPM	Counts per minute
D	Door(s)
DL	Detection limit
dpm	Disintegrations per minute
E	Efficiency Correction Factor
Egress	Act of Exiting
F	Probability of False Alarm
FOM	Figure of Merit
Health Physicist	Person, Persons or Team responsible for setting up day-to-day running and maintenance of the iPCM
HP	*Health Physicist*
HV	High Voltage
Ingress	Act of Entering Keyboard Emulating Id Provider
kBq	kiloBecquerel
Keyboard Emulating Id Provider	Another term for USB Barcode Reader
L	Lead
LAM	Large Articles Monitor
LCD	Liquid Crystal Display

LED	Light Emitting Diode
LVD	Low Voltage Directive
MAct	Minimum Detectable Activity
mCi	Milli Curie
MDA	Minimum Detectable Activity
NBR	Natural Background Reduction
NE110 equivalent	Term referring to a specification of plastic
nCi	nanocurie
NORM	Naturally Occurring Radioactive Material
P	Probability of Detection
PCB	Printed Circuit Board
pCi	picocurie
PM	Personnel Monitor or Portal Monitor
PoFA	Probability of False Alarm
Quickscan	Method used to identify, within the monitoring time (see Tmon), whether the article is either “clearly” contaminated or clear, referred to as “real-dirty” or “real-clean”
RAct	Activity of Contamination
RCC	Residual Contamination Count
SAM	Small Article Monitor
Technician	Personnel who normally repair and maintain the instrument in working condition
tB	Background Update Time
Tcal	Calculated Monitoring Time
ThermoFisher	Personnel who are general users of the system and normally carry out routine diagnostic and test functions
Tmax	Maximum Monitoring Time
Tmin	Minimum Monitoring Time
Tmon	Actual Monitoring Time
User	Anyone associated with or operating the instrument.
V	voltage

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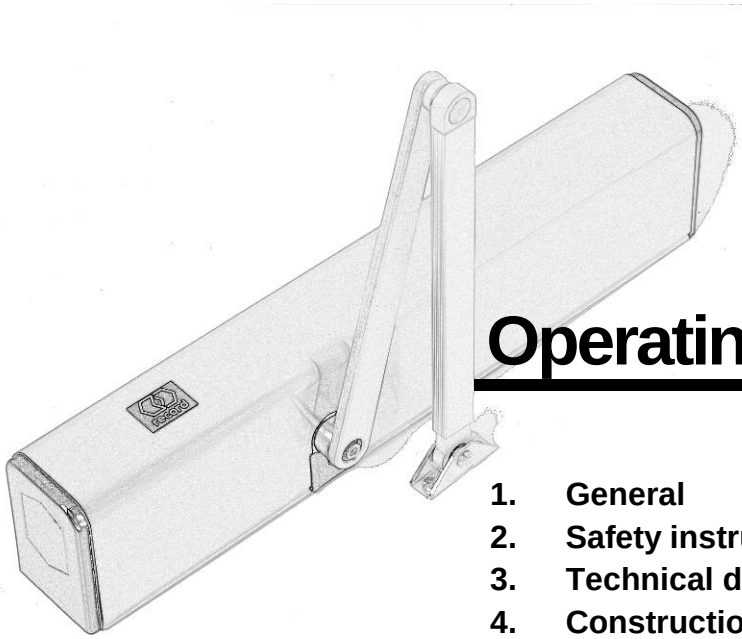
Automatic
Swing Door Operator
DFA 127



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record

Date: 11/2006, BU article-no.: 127.109.265 B

1 General

These operating instructions are intended for the record DFA 127 FP EU or record DFA 127 FP GG EU automatic swing door operator (herein after referred to as DFA 127). The operator is the person responsible for the technical maintenance of this door system.

These instructions describe the use of the record DFA 127 swing door operator. They form the basis for satisfactory functioning.

These operating instructions should be read by the door operator before commissioning and the safety instructions observed!

It is recommended to keep these operating instructions close to the automatic sliding door.

Product designation:	***Automatic swing door operator***
Product name:	***record DFA 127 FP EU or record DFA 127 FP GG EU***
Serial number:	_____ (please complete when installing)

2 Safety instructions

The record DFA 127 swing door operator has been constructed in accordance with the latest state of the art and the recognised technical safety regulations, including limiting of forces and speeds. Nevertheless, danger can arise for the user if not used as intended.

Installation, maintenance and repairs to the record DFA 127 must only be performed by qualified and authorized personnel (technicians).

2.1 Use as intended

The DFA 127 swing door operator is constructed exclusively for normal service with swing doors in dry rooms and must be installed within or inside buildings.

A different application or use extending beyond this purpose is not considered use for the intended purpose. The manufacturer declines all responsibility for resulting damage; the operator alone shall bear the associated risk.

Use for the intended purpose also includes observation of the operating conditions specified by the manufacturer, including use and adjustment of the correct type of arms, in addition to regular maintenance and repair.

Unauthorised modifications to the automatic door operator exclude any liability of the manufacturer for resulting damage.

2.2 General safety and accident prevention regulations

In general no safety devices (sensors) may be dismantled or put out of service.

During the learning cycle (which must only be performed by trained personnel) the safety devices (sensors) are switched off! It must be ensured, therefore, before initiating the learning cycle that no persons or objects are situated in the danger zone of the moving door leaves during the operation in order to avoid injury or damage!

No objects must be placed in the opening zone / path of the swing door to avoid crushing and shearing points!
The safeguard for crushing and shearing strains at the side edge must be provided by the manufacturer..

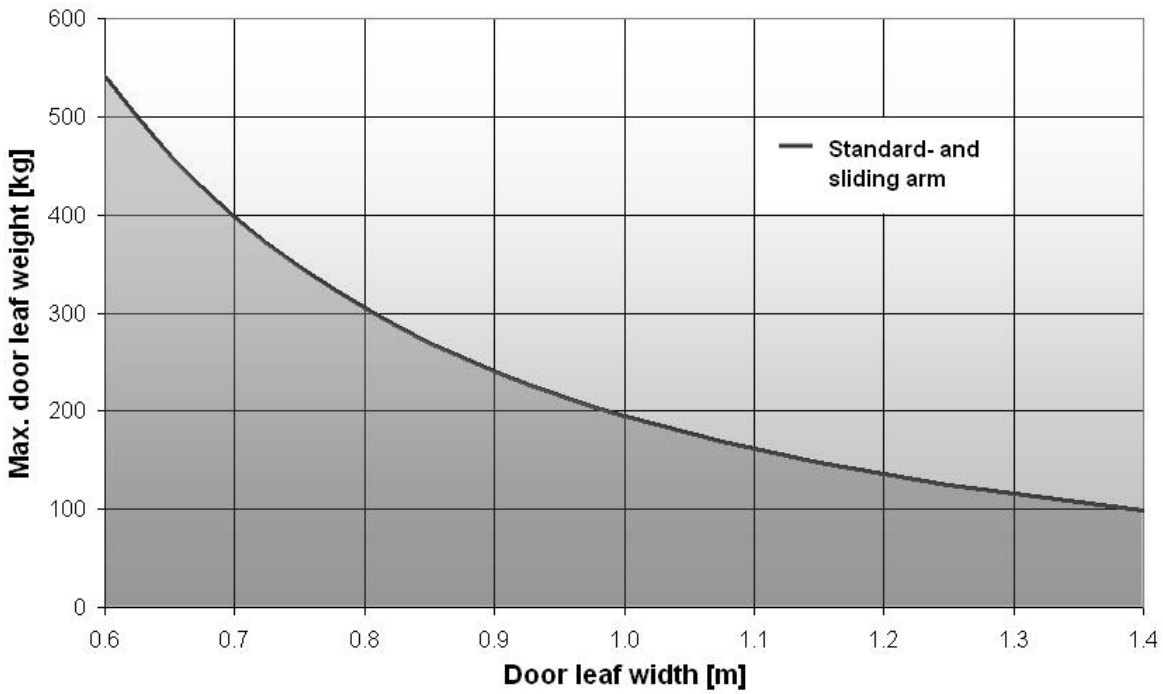
3 Technical Data

Dimensions:	Operator 600 x 85 x 124 mm (w x h x d)
Operating voltage:	230V~
Power consumption:	Standby 13 W, rated power 67 W
Max. torque:	50 Nm
Opening angle:	Adjustable from 70° to 115°
Time delay:	Adjustable from 0 to 20 seconds
Opening speed:	Adjustable from 3 to 20 seconds
Closing speed:	Adjustable from 5 to 20 seconds
Noise emission	-18 dB

Environment conditions

Temperature range:	-15 to + 50°C
Humidity range:	Up to 85% relative humidity, non bedewing

3.1 Permissible door leaf weights and door widths



The curves are calculated using to the following formula:

$$J = 1/3 \cdot m \cdot b^2$$

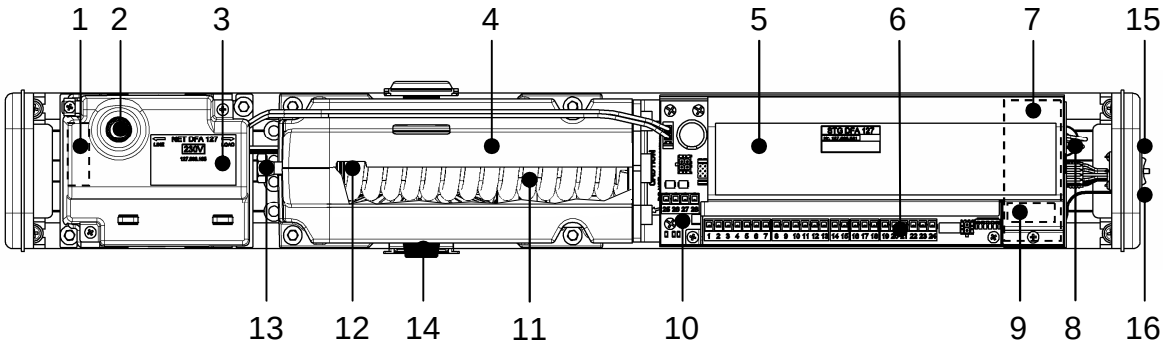
Standard arms : J max. 65 kgm^2

Slide arms : J max. 65 kgm^2

Key : J = mass moment of inertia [kgm^2]
m = door leaf weight [kg]
b = door leaf width [m]

4 Construction and Function

4.1 Construction



Key to illustration:

1	Mains connection terminals	9*	Slide switch S1 (rotating direction)
2	Fine-wire fuse	10*	Multifunctional switch MF on STG
3	Power supply NET	11	Closing spring
4	Drive unit ATM	12	Vision panel adjust. spring tension
5	Control unit STG	13*	Adjusting screw for spring tension
6	Connection terminals control unit	14	Connectors for arms (both sides)
7	Motor print MOT	15	Standard switch BDI
8	ATE drive unit terminals	16	Status signal and Reset button

* Do not change any settings or adjustments! These operations are reserved exclusively for trained and authorized persons.

4.2 Components

The record DFA 127 swing door operator forms part of an electromechanical swing door system and comprises the following main components:

Control unit STG: Intelligent, learning, microprocessor-controlled control system.

Driving unit ATE: Low maintenance DC geared motor with electronic path measurement and integral thermostatic protective switch, gear box with adjustable spring tension.

Power supply NET: Compact 230 V power supply with integral input filter and over-voltage protection.

Control unit BDE: As required with convenient, simple mechanical control unit and / or a programmable electronic BDE-D.

Construction and Function

Arm types: Power transmission to the door leaf by use of standard arm pushing or sliding arm pulling/pushing.

Locking VRR (optional): It is possible to connect an electrical door opener (24VDC) to the operator.

Sensing units: Aesthetic actuating and self-monitoring safety elements with adjustable sensitivity ensure optimum, smooth and reliable operation of the door system.

4.3 Functional description

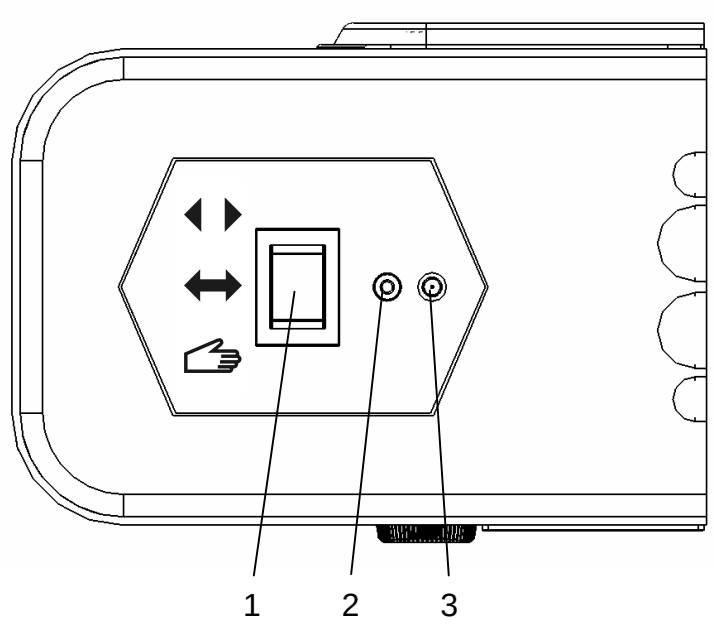
In the standard "Automatic" mode of operation the door system opens by the response of an actuating device (e.g. radar unit) to persons or objects approaching. The door closes after the door hold-open time, provided no further opening pulse is received.

In the "Lock" mode of operation, the door is only opened by actuation of an optional key-operated contact (SSK). The door closes after the SSK door hold-open time, provided no further opening pulse is received.

An obstacle to the swing door leave during ***Closing*** leads to an immediate reopening (reverse). The obstacle position is recorded in the door operator and this position is approached slowly when next closing. An obstacle to the swing door leaf when ***Opening*** results in an immediate stop.

5 Operating instructions

5.1 Mech. control elements and indication



1 Mechanic BDI with 3 positions (control toggle switch)
2 Reset button
3 Status signal

Mechanical BDI (control toggle switch)

The following operational modes can be set up with the 3-position toggle switch on the side cover:

Manual operation
In this operation mode, the DFA works as a normal door-closer. It can easily be opened manually, and then closes automatically. The connected actuating elements are inactivated.

Automatic
The door opens and closes automatically, either by activation of an actuating element or by pushing with activated touch control.

Continuously open
The door opens and remains in the open position. If an obstacle is encountered while opening, the DFA will attempt during the next few seconds to get the door into the set open position. If the obstacle is still present, the current position will be accepted as the continuously open position.

Operating instructions

The mechanical BDI is by factory default always connected and active on a DFA 127. If an additional electronic BDE-D is connected, the operating mode is set by a defined priority structure from the BDE with the highest priority.

The priority and the code shown in the following table apply to the operating mode, whereby BDE2 (S2) and BDE1 (S1) represent the two input terminals of the control unit (**à** J7/1 + J7/2, p.c.b. BDE-M) for the mechanical BDE:

(L = interruption or 0V, H = +24V)

Mechanical BDI (toggle switch)		**Electronic BDE-D**	
BDE2 (S2)	**BDE1 (S1)**	**Function**	**Priority** (1=highest)
		locked	1
		one-way	2
L	H	continuously open	3
H	L	manual	4
L	L	automatic	5

The BDE-D indicates the current operating mode.

If an operating mode is set on the BDE-D, which has no current priority, the status message 62 is displayed.

Reset button

After pushing for approx. 5 sec. a new start of the control is performed (software reset). After the reset the LED lights up permanently.

Status signal

- Remains off if no fault is present.
- Will blink if a fault is present (see status and fault signals / chapter 8)
- Does light up permanently during a reset.

5.2 Auxiliary controls on the control unit STG 127

General:

The CONTROL UNIT STG 127 operates with active HIGH level, i.e. a +24 V level must be applied to activate a function. Safety inputs are activated during interruptions.
The signal ground (0V) is connected to protective earth.

Jumpers:

J14:	Master / Slave jumper at position M1 for master (factory setting) jumper at position S1 for slave
J13:	CAN line termination

LED's:

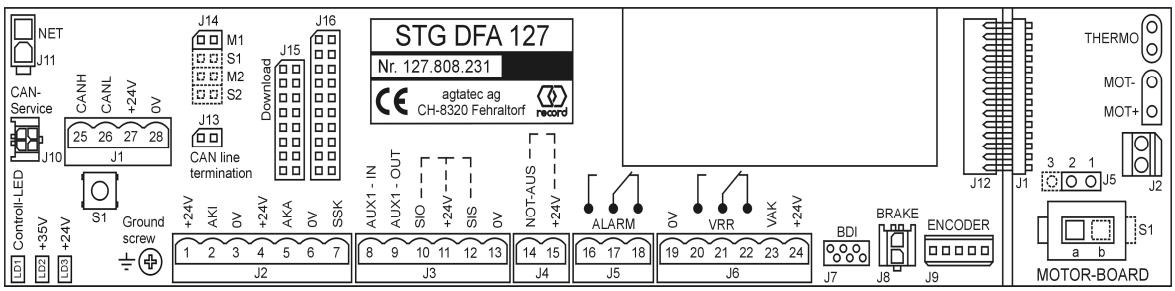
LD1: (red)	control LED for push-button operation (S1)
LD2: (green)	+35V Off for power failure
LD3: (green)	+24V Lights if +24V present. Caution: in the event of a power failure processor reset takes place 1 second after this LED extinguishes.

Push button S1

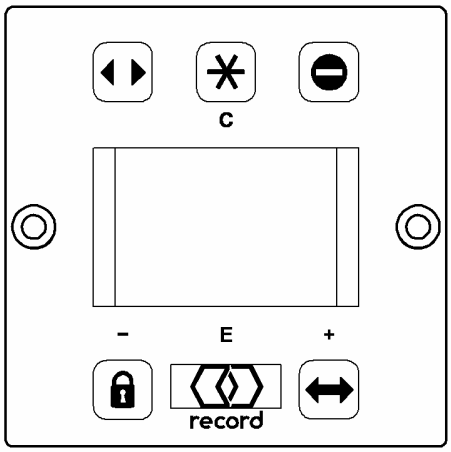
This is a multifunctional switch on controller (MF).

The use of this switch is reserved exclusively for trained and authorized persons.

Top view of the control unit STG:



5.3 Functions of electronic controller BDE-D (optional)



The electronic controller BDE-D is an easily operated input and output device for the control and adjustment of record door operators. Logically arranged push buttons allow an intuitive operation and navigation through the operator-specific menu. The LCD with backlight shows data and information about the door status with symbols and text messages.
Additional information can be taken from the manual of the BDE-D (No. 903 109 271).

5.4 Operation modes

Automatic
Normal function
Table to signals (X marks a release reaction)

	CLOSED	OPENING	OPEN	CLOSING
AKI	x	x	x	x
AKA	x	x	x	x
SSK	x	x	x	x
SIO		x	x	x
SIS			x	x
TIPP	x			

One-way traffic
In one-way traffic mode people cannot enter the room from the outside but they can leave it from the inside.
Table to signals (X marks a release reaction)

	CLOSED	OPENING	OPEN	CLOSING
AKI	x	x	x	x
AKA*		x	x	x
SSK	x	x	x	x
SIO		x	x	x
SIS			x	x
TIPP				

* AKA is active as safety device while closing

Operating instructions

Manual operation
The door can be opened and closed by hand.

Open continuously
The door is opened and stays open.

Locked
In the operation mode Locked the locking is activated.
Table to signals (X marks a release reaction)

	CLOSED	OPENING	OPEN	CLOSING
AKI		x	x	x
AKA		x	x	x
SSK	x	x	x	x
SIO		x	x	x
SIS			x	x
TIPP				

Reset
After pushing on the button

for approx. 5sec. this status message on the display is:

No
Reset Operator?
Yes

Pushing again on the

button resets the operator.

6 Configurations

6.1 Parameter Overview

record parameter overview sheet DFA 127 SW from V1.30

Master or Slave

Please always leave the parameter overview sheet in the operator even when the STG is replaced!

D = Value will reset after default parameter loading
S1 = Slave 1 or Slave 2
M = Change in parameter only with multifunctional button on control unit (technical level)

All parameter modifications must be marked as follows in the relevant box:
Speedo: **programmed value**
parameter value: **X** (mark)

Parameter number				Parameter value (**factory settings** printed bold)					
D	S1	Description	M	1	2	3	4	5	6
		DRIVING CYCLE							
X		Closing speed			*(Speedo)*				
X		Opening speed			*(Speedo)*				
X		Acceleration	M		*(Speedo) Different accelerations*				
X		Latch check	M		*(Speedo) Start latch check by closing*				
		TIME DELAY OPEN							
X		Time delay open			*(Speedo)*				
X		Time delay SSK			*(Speedo)*				
		DRIVE							
X	X	Opening angle			*(Speedo)*				
X	X	Collision			*(Speedo)*				
	X	Brake	M	**Without**	Closing position	Opening position	Open/Clos pos.		
	X	Types of arms	M	Standard arm	**Sliding pullling**	Sliding pushing	Inheader		
		Invers	M	**Disabled**	Enabled				
	X	Spring type	M	**Unknown**	EN 4	EN 5	EN 6		
X		Limit open	M	**Disabled**	Enabled				
		ENTRANCE SYSTEM							
		Fire alarm	M	**Disabled**	Enabled				
X	X	Control	M	**Single control**	Master control	Slave control			
X		Interlock type	M	**Without inter-lock**	Master-Slave *(single leaf inter-lock control)*	Master-Master *(double leaves interlock control)*			
		Door type	M	**Basic operator**	USA	USA Low Energy	EU Low Energy		
		MS 2-LEAVES							
X		Function AKA	M	**Master+slave**	Master only				
X		Overlap	M		*(Speedo) 0 = No overlap*				
X		Open sequence	M		*(Speedo) 0 = Simultaneous opening*				
X		Close sequence	M		*(Speedo) 0 = Simultaneous closing*				
		MANUAL CONTROL							
X		During closing	M	**Disabled**	Enabled				
X		When locked	M	**Disabled**	Enabled				
X		Collision	M	**Disabled**	Enabled				
X		Support during closing	M	**Disabled**	Constant	Cumulative	Final bang	Slowly, cumula-tive	Slowly, final bang
X		Active sensors	M	**Disabled**	SIS disabled	SIS enabled			
X		Closing speed	M		*(Speedo)*				
		CONTROL PANEL							
X	X	Mech. panel	M	**3 Pos. (AUTO)** *Manual; Automatic; Cont. open*	4 Positions *Automatic; Manual; Cont. open; Locked*	3 Pos. (OFF-A) *Automatic; OFF; Cont. open*	3 Pos. (OFF-M) *Manual; OFF; Cont. open*	3 Pos. (Lock-A) *Automatic; Locked; Cont. open*	3 Pos. (Lock-M) *Manual; Locked; Cont. open*
		BDE-D (submenu)							
		Language	M	Deutsch	Français	**English**	English US		
		Keyboard	M	**Normal**	OFF-Mode				
		Contrast BDE 1	M		*(Speedo)*				
		Contrast BDE 2	M		*(Speedo)*				
		Light time	M		*(Speedo)*				
		LOCKING							
		Locking function	M	**Normally locked**	Always locked				
		Lock type	M	**Standard**	Locking bolt	Magnet	Pulse		
		VRR manually	M	**Disabled**	Enabled				
		Start delay	M		*(Speedo)*				
		INPUT							
X		AUX1_IN	M	**Disabled**	BEA Bodyguard				
X		AKA_IN	M	**AKA**	Railbeam				
		OUTPUT							
X		AUX1_OUT	M	**Disabled**	BEA Bodyguard	Test closed	Test open		
		MISCELLANEOUS							
X	X	Push to actuate	M	**Disabled**	Normal *(motored)*	Slow *(motored)*	HB with sensors		

Order number:	**Client:**							
Programming by end customer / changes	Date	Initials						

This parameter overview shows all possible settings. Depending on drive type and configuration the access is restricted.

Configurations

Configurations of the DFA 127 can only be made with the electronic BDE-D. If a toggle switch is connected, a BDE-D must be connected briefly for the configuration.

Further information for parameter changes can be taken from the user manual of the BDE-D (no. 903 109 271).

Please always leave the configuration review sheet in the drive!

6.2 Parameter description

Parameter	Setting range	Factory default	Description
DRIVING CYCLE			
Closing speed	0 - 40 (5 – 20 s)	18	Slider control with 40 steps
Opening speed	0 - 40 (3 - 20 s)	36	Slider control with 40 steps
TIME DELAY OPEN			
Time delay open	0 - 40 (0 - 60 s)	2	Effective with AKA, AKI and push to actuate 0 - 20: Steps of 1 s 21 - 40: Steps of 2 s
Time delay SSK	0 – 40 (0 - 60 s)	4	Effective with SSK 0 - 20: Steps of 1 s 21 - 40: Steps of 2 s
DRIVE			
Opening angle	0 - 40	35	The opening angle is estimated during the calibration run and is equivalent to the value of 40.

6.3 Different factory defaults for door types Low Energy

Parameter	Factory default	Parameter	Factory default
DRIVING CYCLE			
Closing speed	10	Opening speed	20

7 Maintenance instructions

7.1 General

The record DFA 127 swing door operator is a product of the latest technology. It has been carefully made and only leaves the factory following thorough testing. Automatic swing doors should be operated and maintained to ensure safety at all times.

7.2 Care

The entire swing door system can be cleaned with a damp cloth and commercially available cleaning agents. The cleaning agent must be harmonised to the surface which has to be cleaned.
It is recommended to select the "Continuously open" or "Locked" mode of operation for this purpose, so that the door does not continually open and close unnecessarily.

7.3 Maintenance, periodic inspection

It is recommended to have a technical safety test with servicing performed by a specialist before first commissioning and as required, but at least twice a year.

Regular testing and servicing by our fully trained personnel therefore offers the best guarantee for a long service life and satisfactory operation. We therefore recommend the signing of a maintenance agreement. Our service department will be pleased to submit a proposal.

If nevertheless a fault should occur, which you cannot eliminate (see section 8) our service organisation or the maintenance personnel of our agents are available.

7.4 Service centres

In Switzerland: Phone +41 (0) 44 954 92 92 / Fax +41 (0) 44 954 92 00

Alternative service centre: _____

8 Action in case of faults

8.1 Fault indication

Various indications are given for an irregularity or fault depending on the control unit connected BDE-E or BDE-M.

When using a mechanical BDE (control toggle switch)
With the mechanical control unit it is not possible to display a detailed status signal. If a fault occurs (will be shown by the status signal on the side cover), please proceed according to section 8.2.

When using an electronic BDE-D

General

Any current operational faults in the drive system will be displayed in the Standard screen. If several faults are active, they will be numbered: e.g. Fault **1/2**

In case of an irregularity the display changes automatically from mode of operation level to error display. Every 2 seconds the backlight changes between normal /invers. Several errors can be displayed (e.g. 1/2 means: error no. 1 of total 2 errors).
After 10 seconds the telephone number of the responsible service centre is indicated alternating to the fault indication. The failure indication and the phone number change every 5 seconds, while the inverse flashing is remaining. The described sequence applies to all failures. However, previously the phone number must have been given by an authorised specialised person.

Information about the drive system, such as the software version, can be read out by pressing the record key.
After pressing this key once again, the phone number of the responsible service centre and the last appeared fault indication is displayed in the screen. If the fault message consists of several lines the first line will be displayed only.

Status signals with a "W" are warnings. For these the fault relay contact output is not connected. Elimination of the irregularity leading to the status signal is performed according to section 8.2

A status can usually be deleted by pressing the record key for 5 s (= Reset). This produces a new start in the control unit.
If, however, the cause of the fault has not been eliminated, the status message will appear again if the fault occurs again.

Action in case of faults

8.2 Error elimination

The majority of faults can be eliminated by consulting the following table. If the fault cannot be eliminated even after working through the table, please contact the service centre. Please also contact the service centre directly when no recommended action is specified in the table.

Status	Symptom, fault, door behaviour	Cause	Action (consult service if no recommend-action)
03	Door remains open	Actuating device inside active longer than 60 s	
05	Door remains open	Actuating device outside active longer than 60 s	
06	Door does not unlock	Unlocking fault	
23		Control unit SLAVE defective	Reset by service fitter
25		MASTER / SLAVE connection interrupted	Reset by service fitter
31	Door stops	EMERGENCY STOP button operated	Release EMERGENCY STOP button
37	Door stops	Faulty motor current	
38	Door changes to manual control	Excess temperature motor	Wait until motor has cooled
39	Peripheral devices take too much power	Overload on +24 V supply	Reset by service fitter
41	Door stops	Motor 1 thermal sensor defective	Reset by service fitter
43	Door stops	Incremental transmitter defective	Reset by service fitter
45	Minimum hold-open time increased to 20 secs.	Motor current time product too large	Wait until motor has cooled
46	Door stops	Control unit defective	Reset by service fitter
47	Door remains closed	SIO sensor longer activ than 60 sec.	Remove obstacle from surveillance range of sensor
50	Door stops	Control unit defective	Reset by service fitter
52		No valid drive parameter	Initiate calibration run
53	Door stops	Interruption motor	Reset by service fitter
54 W	Door jolts possibly while opening	Calibration run	Initiate 1 opening cycle
59	Door stops	SIS sensor longer activ than 60 sec.	Remove obstacle from surveillance range of sensor
60	Door stops	Parameter memory defective	Reset by service fitter
61	Door remains open	Key operated contact active longer than 60 s	Release key contact
62 W	Higher-order mode of operation present	Control unit BDE has no priority	Cancel higher-order mode of operation

Status and fault signals

8.3 Detail description of status indications

General

A status can usually be deleted by pressing the record key for 5 s (= Reset). This produces a new start in the control unit.
If, however, the cause of the fault has not been eliminated, the status message will appear again if the fault occurs again.

The following list contains the causes of faults in decreasing possibility. The fault at the bottom of the list has the smallest probability to occur in the control unit STG.

Status 3: **AKI sensor active longer than 60 s**
Automatically reset if everything is in order, or by service fitter

Status 5: **AKA sensor active longer than 60 s**
Automatically reset if everything is in order, or by service fitter

Status 6: **Unlocking error**
Bolt possibly jammed
Reset by service fitter

Status 9: **“Opening” unsuccessful (after 4 collisions)**
Check the interlock / remove obstacle
Reset through service fitter

Status 11: **Faulty motor current**
Possibly faulty wiring in prefabricated cables
Replacement by service fitter

Status 23: **Slave control unit defective**
Replacement by service fitter

Status 25: **Slave connection (CAN) to Master interrupted**
Clear by service fitter

Status 31: **EMERGENCY STOP operated. Motor relay de-energises**
Reset by resetting the EMERGENCY STOP button

Status 37: **Motor current**
STG or ATE defective
Reset by service fitter

Status 38: **Overheat motor**
Manual control effective
Door leaves possibly too heavy, or too much friction
Reset by motor cooling down or by service fitter

Status and fault signals

Status 39: **Overload on + 24 V supply**
Too many external units possibly connected
Reset by service fitter

Status 41: **Motor – temperature sensor defective**
Motor possibly not connected
Sensor in motor possibly defective or cable break in sensor lead
Reset by service fitter

Status 43: **Incremental encoder fault**
Input cable possibly not connected or cable break in the lead
Motor possibly blocked
Reset by service fitter

Status 45: **Motor current – time product to high**
Motor relay de-energises
Manual control effective
Automatic reset by motor cooling or by service fitter

Status 46: **Control unit STG defective**
Includes the following individual faults:
EPROM, RAM, Watchdog, Imax, ImaxT, difference on SHE-EXT
Reset by service fitter

Status 47: **SIO sensor active longer than 60 s**
Automatically reset if in order, or by service fitter

Status 50: **CPU2 is defective**
Reset by service fitter

Status 51: **Software version**
Software version of Master and Slave do not correspond to each other. Software update by service fitter

Status 52: **No running parameter**
Start calibration run

Status 53: **Interruption motor**
Possibly no connection to motor
Reset by service fitter

Status 54: **Calibration run**
Reset automatically

Status 59: **SIS sensor active longer than 60 s**
Automatically reset if in order, or by service fitter

Status and fault signals

Status 60: **Parameter memory (EEPROM) defective**
Change control unit
Reset by service fitter

Status 61: **SSK active longer than 60 s**
Automatically reset if in order, or by service fitter

Status 62: **BDE has no priority**
Because a higher-level signal is present
Automatically reset on release of BDE-button

Status 72: **Slave connection**
Master has no connection to Slave operator
Reset by service fitter

Status 88: **Difference parameter**
The common parameters of M/S operators do not correspond to each other.
Reset by service fitter

Status 89: **Master connection**
Slave has no connection to master operator
Reset by service fitter

Status 90: **Railbeam active > 60 sec.**
Automatically reset if everything is in order, or by service fitter

Status 91: **Bodyguard active > 60 sec.**
Automatically reset if everything is in order, or by service fitter

Status 92: **STG relay defective**
Replacement by service fitter

Status 93: **Overvoltage 24 V** (from 27V)

Status 94: **Spring calibration**
Automatic reset

Status 95: **Error in sense of rotation**

Status 96: **EEPROM void**

Status 99: **Operator rotates**
The grease in the gear will be dispersed.
Automatic reset

Status 105: **Test brake**
Automatic reset

Status and fault signals

Status 106: **Brake defective**
Reset or reset by service fitter

Status 107: **SIS defective**
A safety sensor (with test input) in closing direction is defective.
Reset by service fitter

Status 108: **SIO defective**
A safety sensor (with test input) in opening direction is defective.
Reset by service fitter

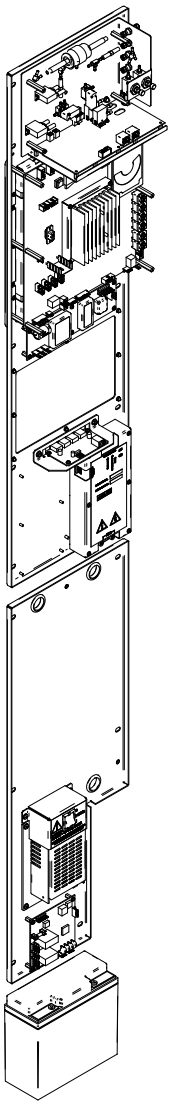
Status 109: **Factory settings**

Status 110: **No motor**
No motor detection during initialisation (motor temperature sensor).
Check motor temperature sensor.
Reset or reset by service fitter

A status number with a "W" is a warning !!

DRG.No. D92591 SHT 1 OF 6

DO NOT SCALE | THIRD ANGLE PROJECTION | IF IN DOUBT ASK!



C.E.P
B39800/A-00160
701415BB
B92601
TOUCH SCREEN CONTROLLER
B92602/A
LCD SUB-ASSY
(LOCATED UNDER ETX BOARD 5712A)
BACKLIGHT INVERTER
702509KF
GAS-FLOW CONTROL BOARD 5709A
SK201
ETX BOARD 5712A
B91918/A
LOUDSPEAKER
11705242
UPPER PLINTH
DC-DC BOARD 5714A
B92604/A
B92596/A
USB CABLE SUPPLIED WITH HUB (702726KM)
B92165/A
GUIDANCE DISPLAY BOARD 5711A
ARRAY HINGE SECTION
5-WAY LED CLUSTER BOARD 5672A
UPPER PLINTH
HV GENERATOR 5713A
DETECTOR HV SUPPLY SEE SHEETS 2&3 OF 6
702324KF
B92605/A
703095KF
KEY SWITCH
GREEN LED
YW OR R BR
SILVER TAG = BLUE
BRASS TAG = GREEN
B92595/A
ROCKER SWITCH
B92617/A
PSU
11705234
BATTERY CONTROL BOARD 5703A
B92594/A
B92597/A
B92609/A
702796KF
NETWORK SOCKET
MAINS IEC INLET
C.E.P
UPPER PLINTH
5659B
NOTE:
CONNECT BOARD TO -ve BATTERY TERMINAL
B92059/A
IN-LINE FUSE PCB
- ve
+ ve
12V BATTERY

ELECTRONICS, POWER & DISPLAY CONNECTION DIAGRAM

ISO THREADS CLASS 6g/6H

MATL.	TOLERANCES UNLESS STATED 1 DEC. PL. ± 0.4 2 DEC. PL. ± 0.15 ANGULAR ± 0.5 DEG.	DRAWN AAS	ISS.	DATE	DOI/MOD.		
SPEC.			A	29/09/08	DOIxxxx		
FINISH. REMOVE ALL BURRS.	SURFACE TEXTURE		B	20/04/09			
	DIMENSIONS IN MILLIMETRES	ThermoFisher SCIENTIFIC Bath Road, Beenham, Reading, Berkshire, RG7 5PR, ENGLAND.					
	√ UNLESS STATED	SCALE N.T.S.	TITLE INTERCONNECTION DIAGRAM FOR iPCM12A			DRG.No. D92591	SHT 1 OF 6
MANUFACTURE TO DIMENSIONS SHOWN. FINISHING ALLOWANCE ALREADY DEDUCTED							

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DRG.No. D92591 SHT 2 OF 6

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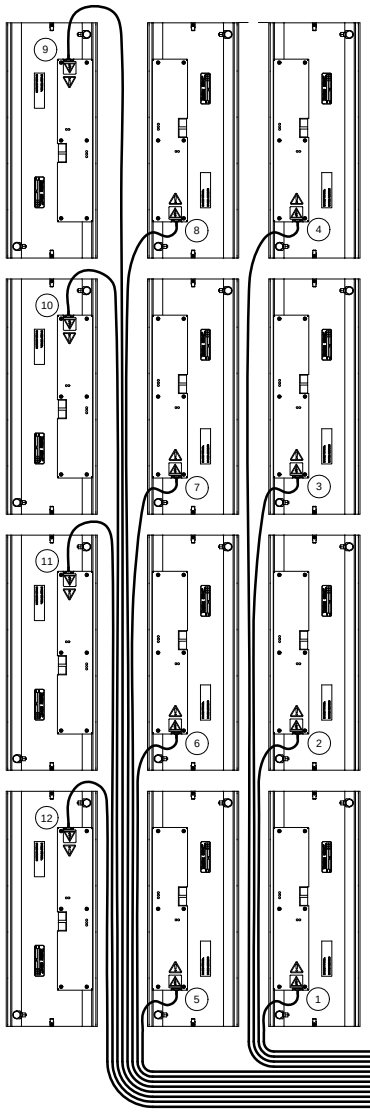
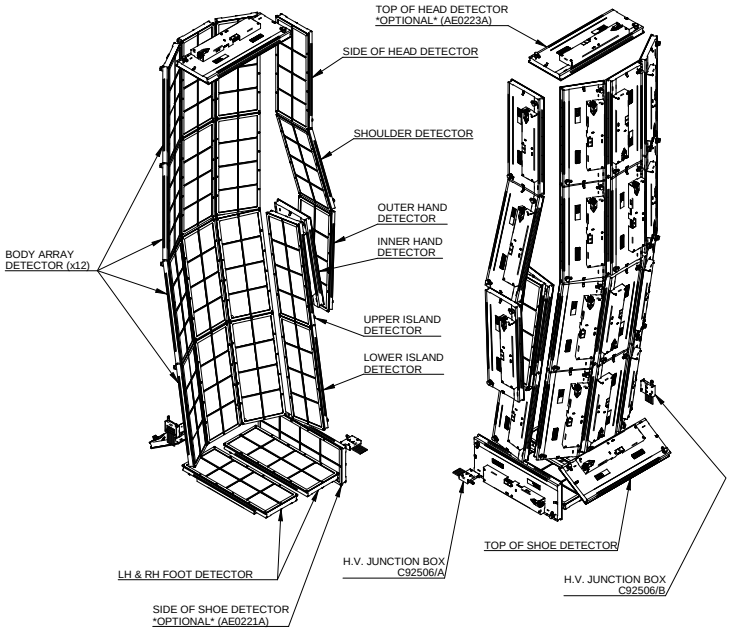
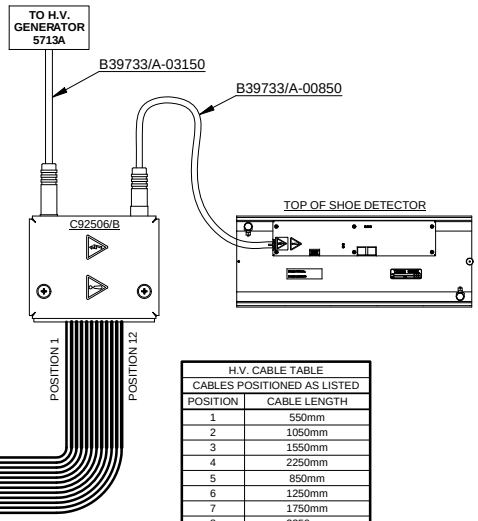
ARRAY DETECTOR CONFIGURATION



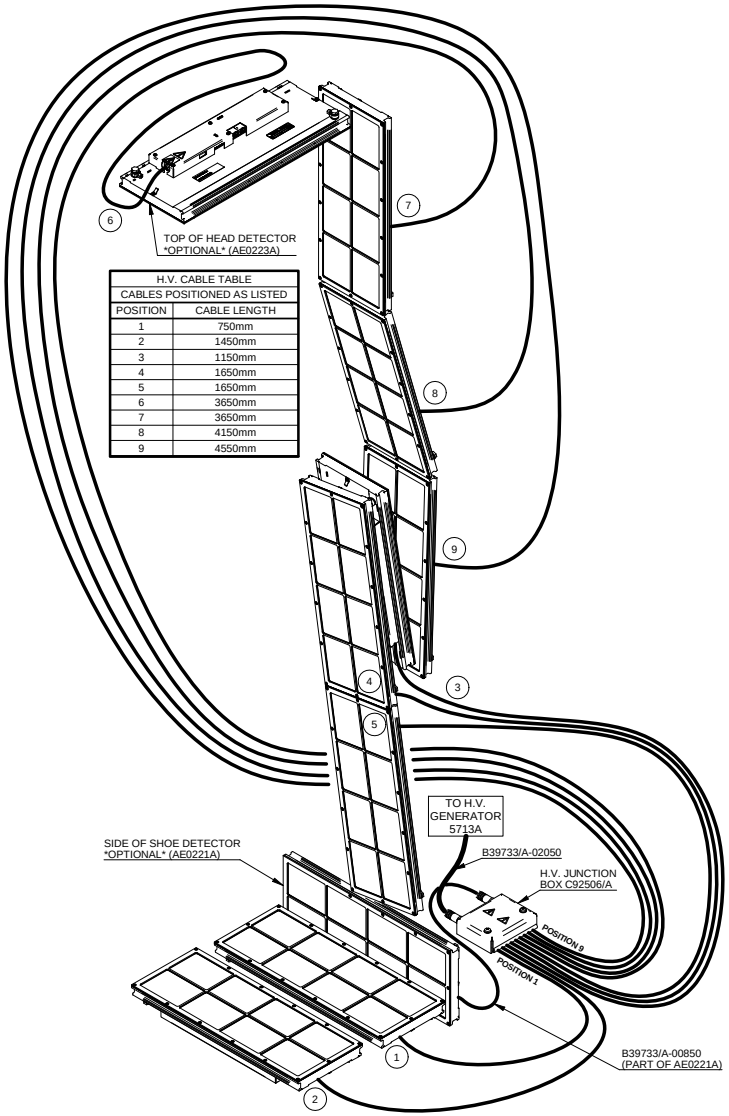




H.V. CABLE TABLE	
CABLES POSITIONED AS LISTED	
POSITION	CABLE LENGTH
1	550mm
2	1050mm
3	1550mm
4	2250mm
5	850mm
6	1250mm
7	1750mm
8	2250mm
9	2600mm
10	2100mm
11	1750mm
12	1250mm

H.V. SCHEMATIC DIAGRAM

FULL DETECTOR CONFIGURATION (EXCL. ARRAY)



H.V. CABLE TABLE	
CABLES POSITIONED AS LISTED	
POSITION	CABLE LENGTH
1	750mm
2	1450mm
3	1150mm
4	1650mm
5	1650mm
6	3650mm
7	3650mm
8	4150mm
9	4550mm

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SPEC.			A	29/09/08	DOIxxxx										
FINISH. REMOVE ALL BURRS.	SURFACE TEXTURE		B	20/04/09											
		DIMENSIONS IN MILLIMETRES	ThermoFisher SCIENTIFIC Bath Road, Beenham, Reading, Berkshire, RG7 5PR, ENGLAND.												
	√ UNLESS STATED	SCALE N.T.S.	TITLE INTERCONNECTION DIAGRAM FOR iPCM12A										DRG.No. D92591		SHT 2 OF 6
MANUFACTURE TO DIMENSIONS SHOWN. FINISHING ALLOWANCE ALREADY DEDUCTED															

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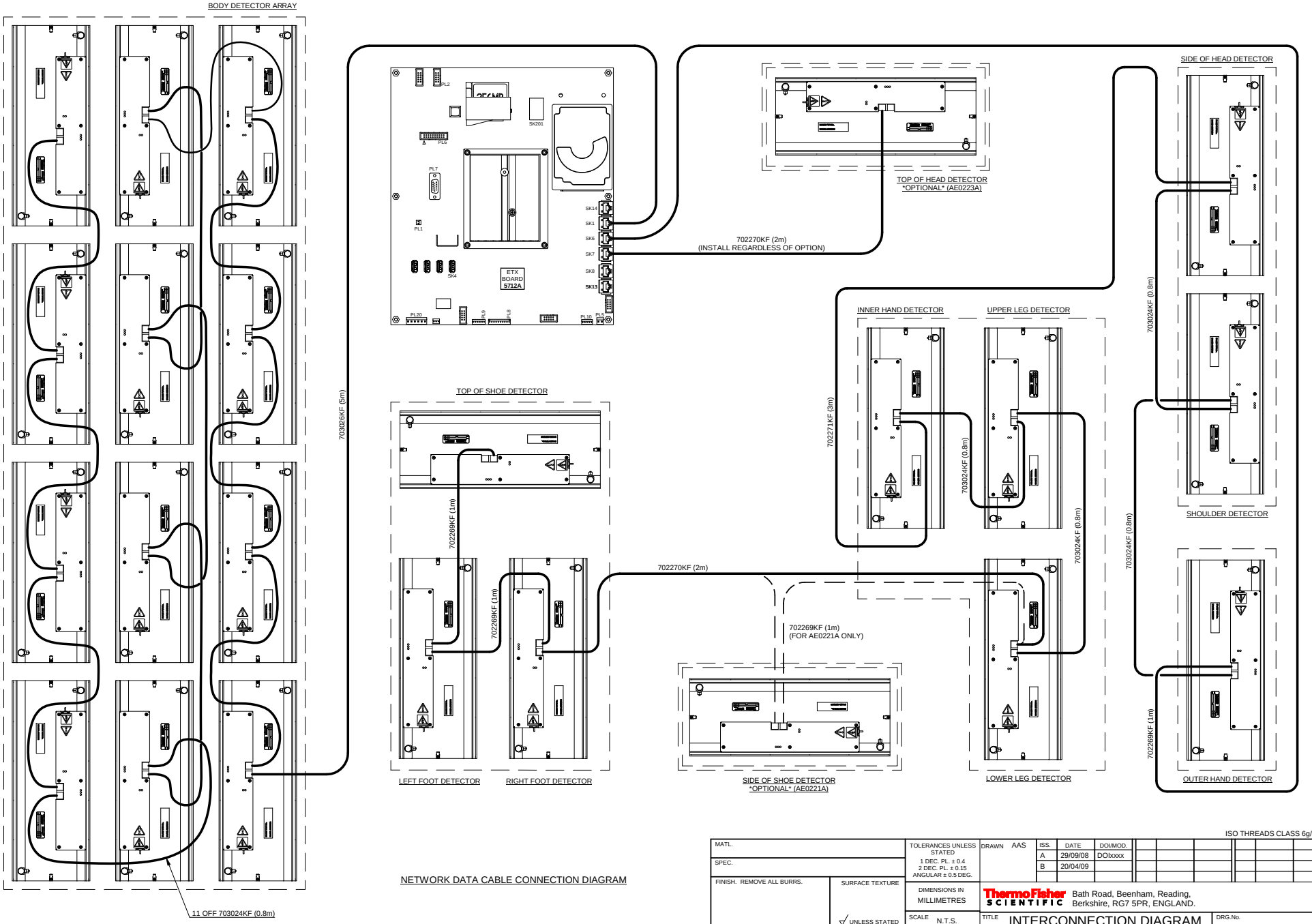
DRG.No. D92591 SHT 3 OF 6



NETWORK DATA CABLE CONNECTION DIAGRAM

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SPEC.			A	29/09/08	DOIxxxx		
FINISH. REMOVE ALL BURRS. SURFACE TEXTURE	DIMENSIONS IN MILLIMETRES	ThermoFisher SCIENTIFIC Bath Road, Beenham, Reading, Berkshire, RG7 5PR, ENGLAND.	B	20/04/09			
√ UNLESS STATED	SCALE N.T.S.	TITLE INTERCONNECTION DIAGRAM FOR iPCM12A	DRG.No. D92591			SHT 3 OF 6	
MANUFACTURE TO DIMENSIONS SHOWN. FINISHING ALLOWANCE ALREADY DEDUCTED							

DRG.No. D92591 SHT 4 OF 6

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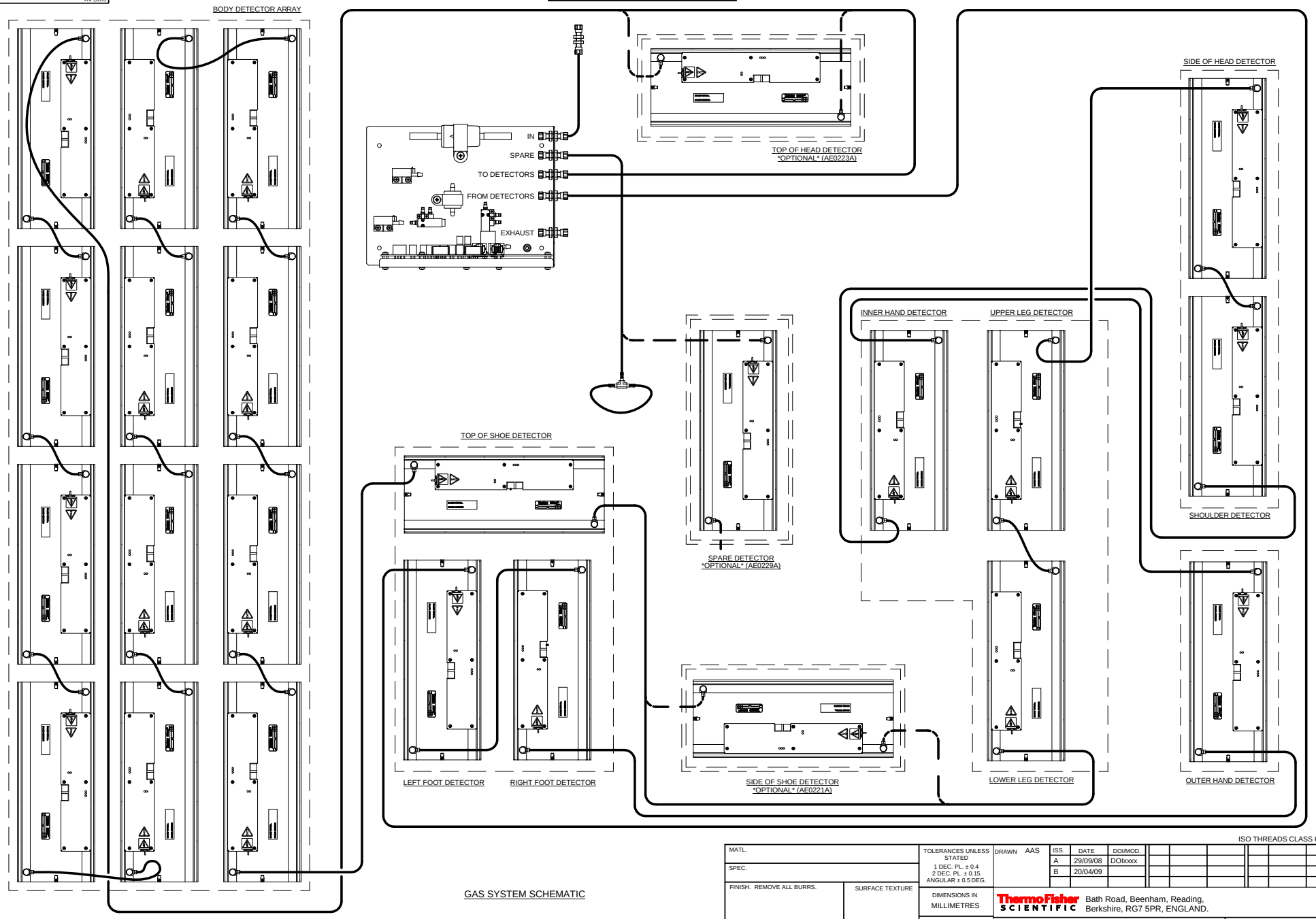

GAS SYSTEM SCHEMATIC

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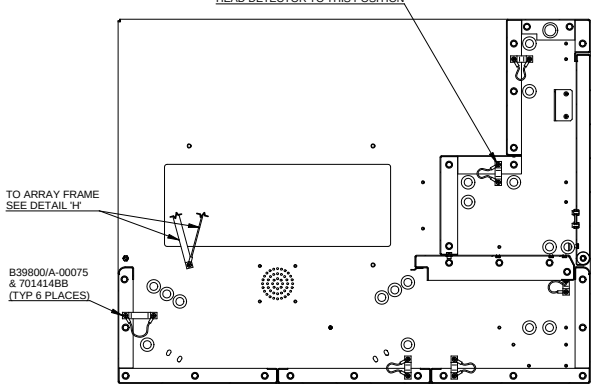
SPEC.			A	29/09/08	DOIxxxx		
FINISH. REMOVE ALL BURRS. SURFACE TEXTURE	DIMENSIONS IN MILLIMETRES		B	20/04/09			
√ UNLESS STATED	SCALE N.T.S.	ThermoFisher SCIENTIFIC Bath Road, Beenham, Reading, Berkshire, RG7 5PR, ENGLAND.					
MANUFACTURE TO DIMENSIONS SHOWN. FINISHING ALLOWANCE ALREADY DEDUCTED		TITLE INTERCONNECTION DIAGRAM FOR iPCM12A	DRG.No. D92591			SHT 4 OF 6	

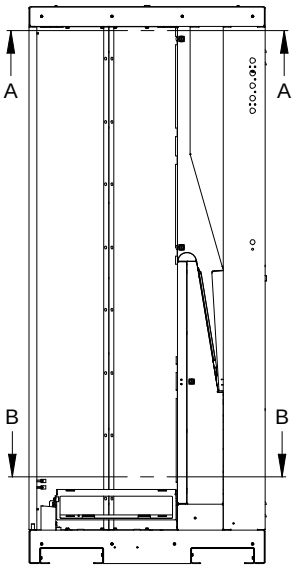
DRG.No. D92591 SHT 5 OF 6

DO NOT SCALE | THIRD ANGLE PROJECTION | IF IN DOUBT ASK!

NOTE:
CHO' STRAP FROM SIDE OF
HEAD DETECTOR TO THIS POSITION



SECTION A-A
1:5



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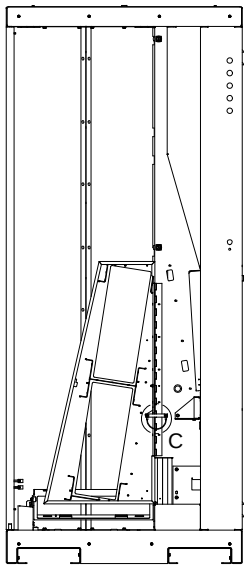
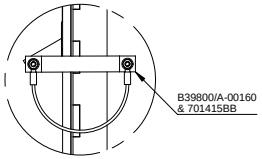
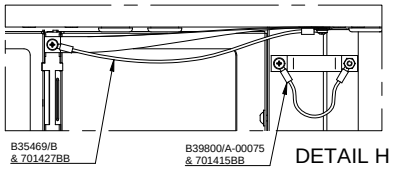


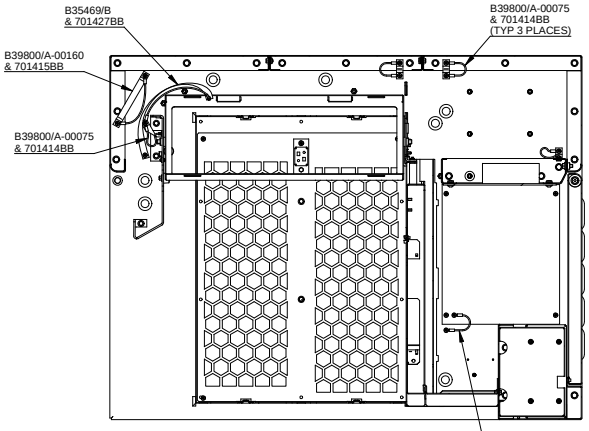
ARRAY REMOVED FOR CLARITY.
ISLAND DOOR IN OPEN POSITION



DETAIL C
1:2



DETAIL H
1:2



SECTION B-B
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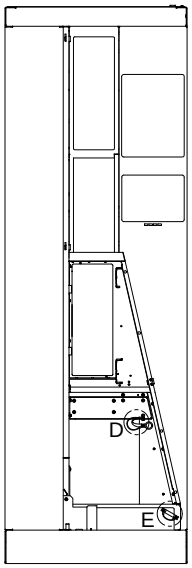
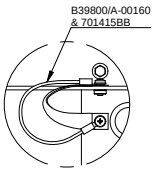
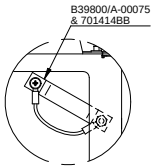


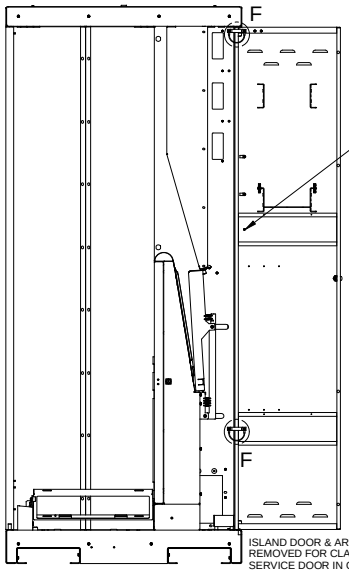
ISLAND DOOR & ARRAY
REMOVED FOR CLARITY



DETAIL D
1:2

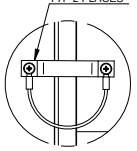


DETAIL E
1:2

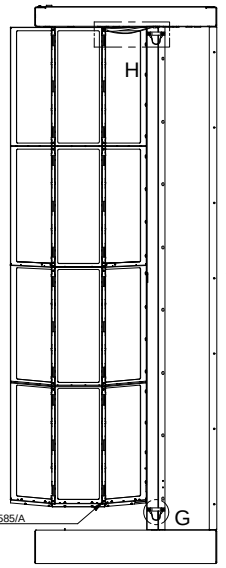


NOTE:
CHO' STRAP FROM
SHOULDER DETECTOR
TO THIS POSITION

ISLAND DOOR & ARRAY
REMOVED FOR CLARITY.
SERVICE DOOR IN OPEN POSITION

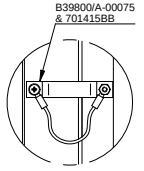


DETAIL F
1:2



ISLAND & VARIOUS PANELS
REMOVED FOR CLARITY.
ARRAY IN OPEN POSITION

FOR ARRAY FRAME
TO ARRAY HINGE
EARTH BONDING
REFER TO G.A. D92585/A



DETAIL G
1:2

ISO THREADS CLASS 6g/6H

BASIC CABINET PANEL ASSEMBLY EARTHING GUIDE

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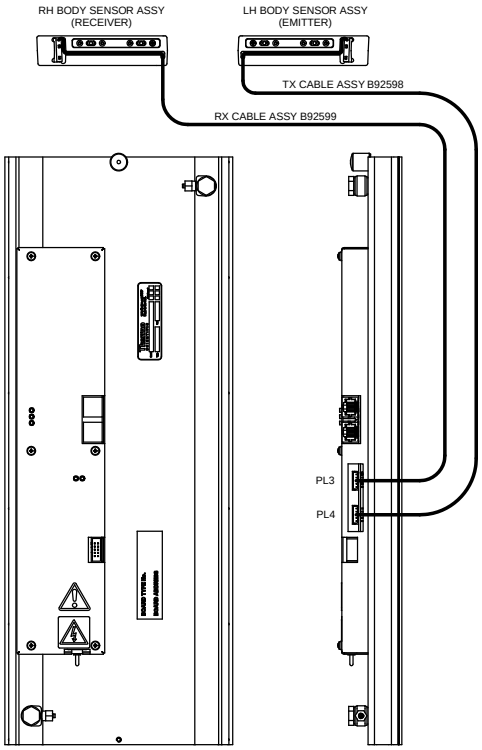
MATL.	TOLERANCES UNLESS STATED 1 DEC. PL. ± 0.4 2 DEC. PL. ± 0.15 ANGULAR ± 0.5 DEG.	DRAWN AAS	ISS.	DATE	DOI/MOD.		
SPEC.			A	29/09/08	DOIxxxx		
FINISH. REMOVE ALL BURRS.	SURFACE TEXTURE ▽ UNLESS STATED		B	20/04/09			
MANUFACTURE TO DIMENSIONS SHOWN. FINISHING ALLOWANCE ALREADY DEDUCTED	DIMENSIONS IN MILLIMETRES	ThermoFisher SCIENTIFIC Bath Road, Beenham, Reading, Berkshire, RG7 5PR, ENGLAND.					
	SCALE N.T.S.	TITLE INTERCONNECTION DIAGRAM FOR iPCM12A	DRG.No. D92591			SHT 5 OF 6	

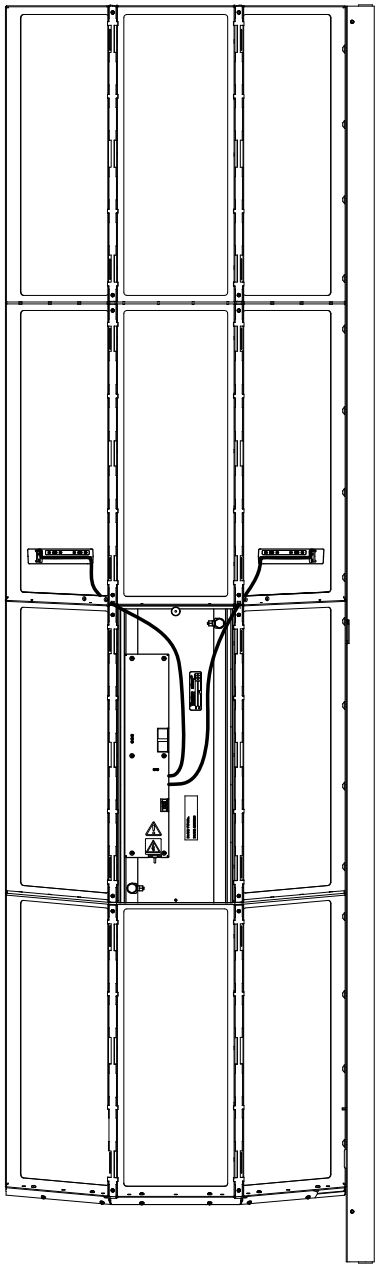
DRG.No. D92591 SHT 6 OF 6

DO NOT SCALE | THIRD ANGLE PROJECTION | IF IN DOUBT ASK!

NOTES:
1. SENSOR IDENTIFICATION;
   RECEIVER - BLACK
   EMITTER - CLEAR
2. CABLE IDENTIFICATION;
   RECEIVER CABLE - 3 WIRES (RED, BLACK, BLUE)
   EMITTER CABLE - 2 WIRES (RED, BLACK)

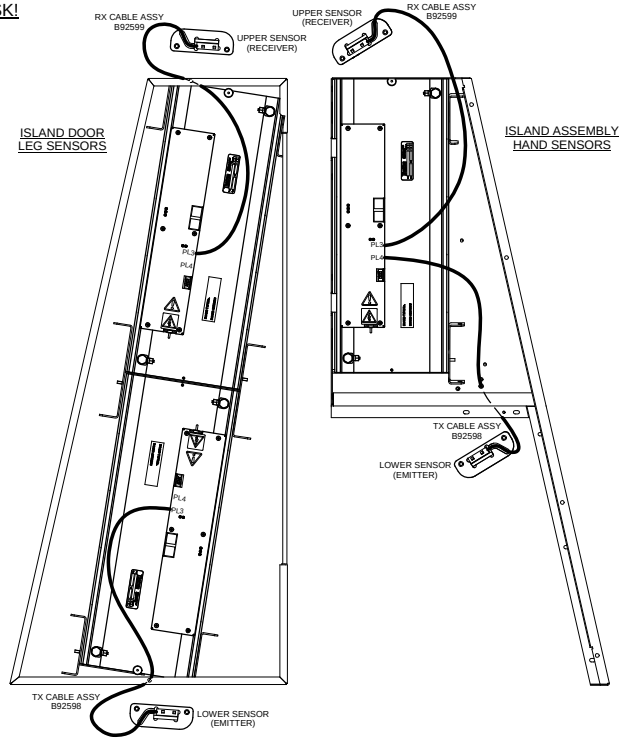
BODY ARRAY ASSEMBLY
BODY SENSORS



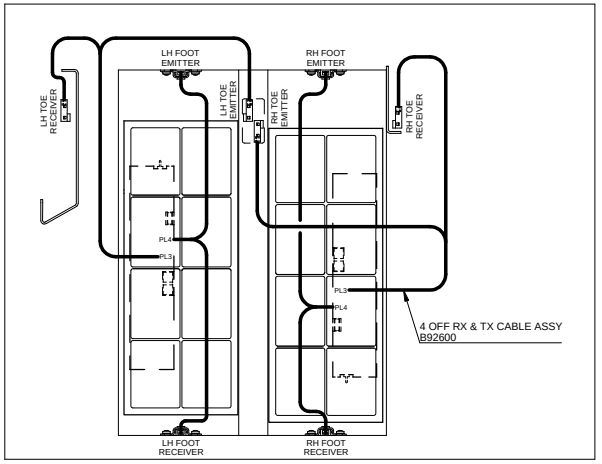


ISLAND DOOR LEG SENSORS

ISLAND ASSEMBLY HAND SENSORS



LOWER PLINTH
FEET & TOE SENSORS



USER POSITION SENSOR CONNECTION SCHEMATIC

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ISO THREADS CLASS 6g/6H

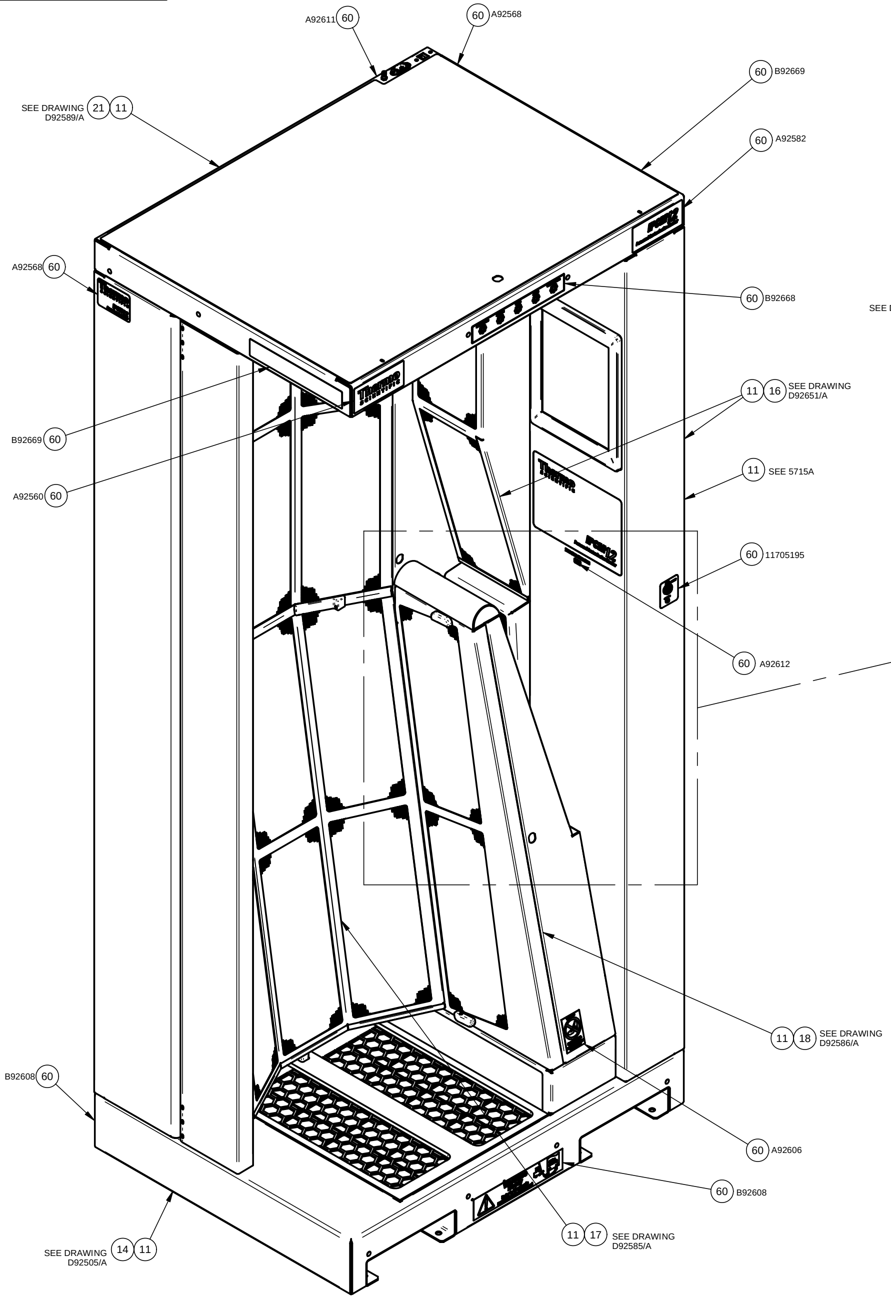
MATL.	TOLERANCES UNLESS STATED 1 DEC. PL. ± 0.4 2 DEC. PL. ± 0.15 ANGULAR ± 0.5 DEG.	DRAWN AAS	ISS.	DATE	DOI/MOD.										
SPEC.			A	29/09/08	DOIxxxx										
FINISH. REMOVE ALL BURRS. SURFACE TEXTURE	DIMENSIONS IN MILLIMETRES		B	20/04/09											
√ UNLESS STATED	SCALE N.T.S.	ThermoFisher SCIENTIFIC Bath Road, Beenham, Reading, Berkshire, RG7 5PR, ENGLAND.													
MANUFACTURE TO DIMENSIONS SHOWN. FINISHING ALLOWANCE ALREADY DEDUCTED		TITLE INTERCONNECTION DIAGRAM FOR iPCM12A	DRG.No. D92591 SHT 6 OF 6												

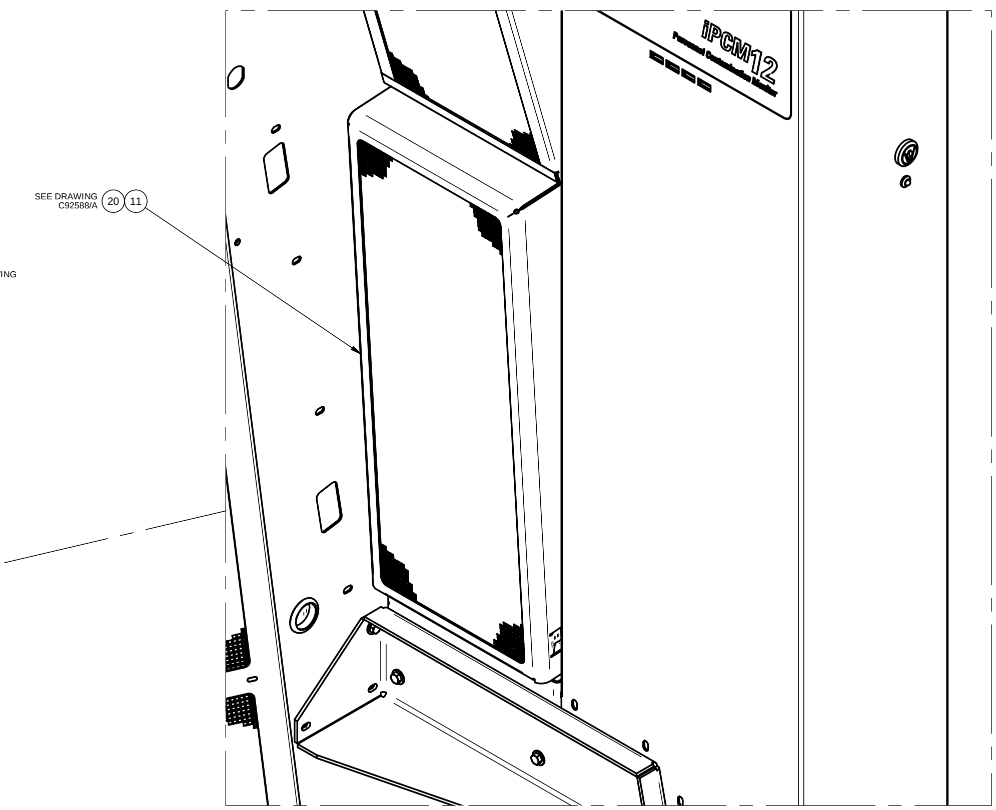
D92590/A
DRG.No.

DO NOT SCALE

THIRD ANGLE PROJECTION

IF IN DOUBT ASK!





OUTER HAND DETECTOR ASSEMBLY
1:2

(ISLAND ASSEMBLY ITEM 18 REMOVED FOR CLARITY)

THIS DRAWING TO BE READ IN CONJUNCTION WITH INTERCONNECTION DIAGRAM D92591

ISO THREADS CLASS 6g/6H

MATL. SEE BOM D92590/A	TOLERANCES UNLESS STATED 1 DEC. PL. ± 0.4 2 DEC. PL. ± 0.15 ANGULAR ± 0.5 DEG.	DRAWN RES	
SPEC. SEE BOM D92590/A			
FINISH. REMOVE ALL BURRS. SURFACE TEXTURE √ UNLESS STATED	DIMENSIONS IN MILLIMETRES	ThermoFisher SCIENTIFIC Bath Road, Beenham, Reading, Berkshire, RG7 5PR, ENGLAND.	
	SCALE 1:5 & 1:2	TITLE GENERAL ASSEMBLY - PCM12A	DRG.No. D92590/A SH 1 OF 3
MANUFACTURE TO DIMENSIONS SHOWN. FINISHING ALLOWANCE ALREADY DEDUCTED			

ISS.	DATE	DOI/MOD.
A	05-02-09	DOIxxxx
B	08/04/09	

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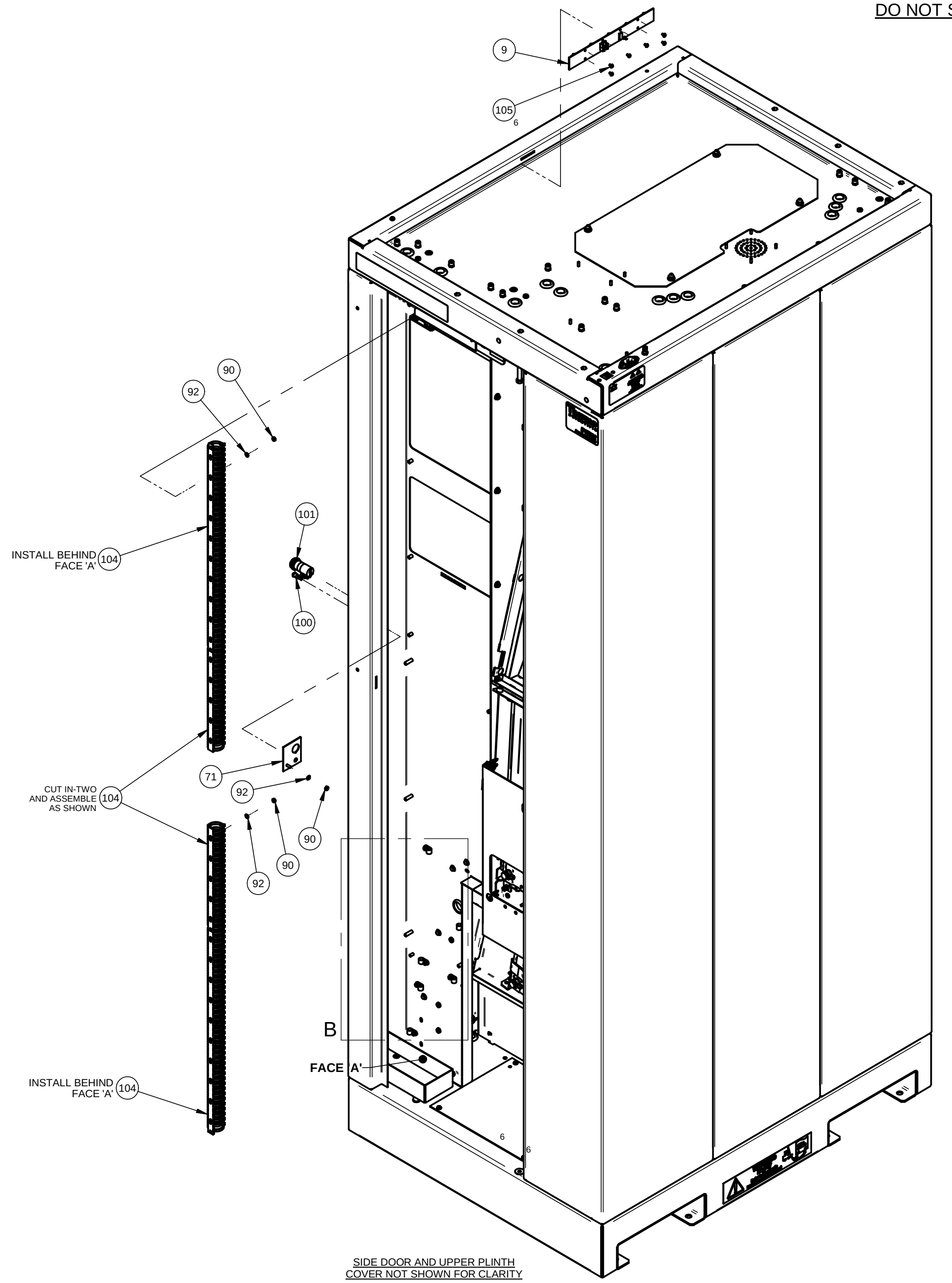
D92590/A
DRG.No.

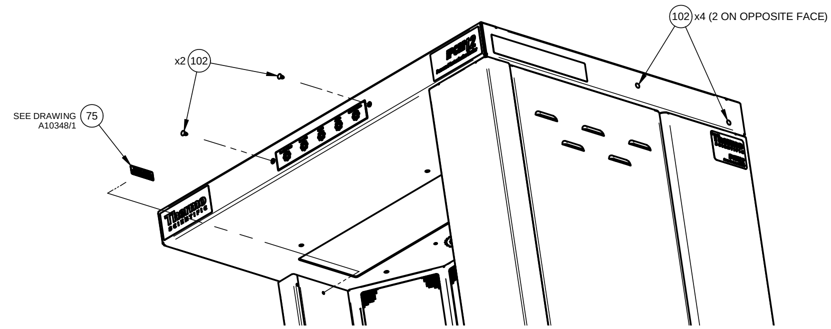
THIRD ANGLE PROJECTION

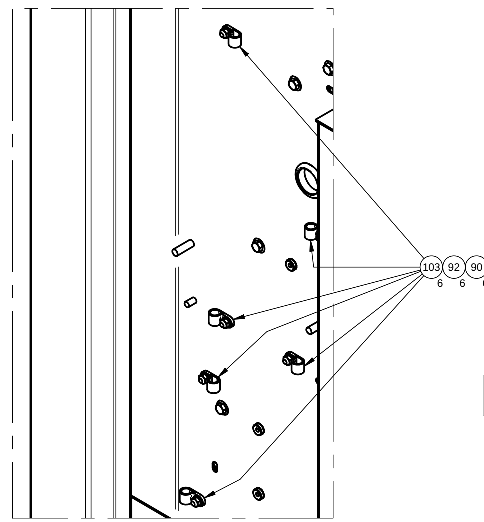
DO NOT SCALE

IF IN DOUBT ASK!



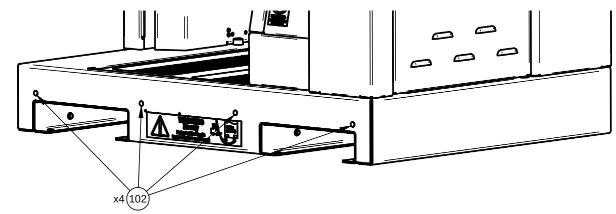
SIDE DOOR AND UPPER PLINTH COVER NOT SHOWN FOR CLARITY





DETAIL B
1:2

THIS DRAWING TO BE READ IN CONJUNCTION WITH INTERCONNECTION DIAGRAM D92591



ISO THREADS CLASS 6g/6H

MATL. SEE BOM D92590/A		TOLERANCES UNLESS STATED 1 DEC. PL. ± 0.4 2 DEC. PL. ± 0.15 ANGULAR ± 0.5 DEG.	DRAWN RES
SPEC. SEE BOM D92590/A			
FINISH. REMOVE ALL BURRS.	SURFACE TEXTURE UNLESS STATED	DIMENSIONS IN MILLIMETRES	ThermoFisher SCIENTIFIC Bath Road, Beenham, Reading, Berkshire, RG7 5PR, ENGLAND.
		SCALE 1:5	TITLE GENERAL ASSEMBLY - PCM12A
MANUFACTURE TO DIMENSIONS SHOWN. FINISHING ALLOWANCE ALREADY DEDUCTED			DRG.No. D92590/A SH 2 OF 3

ISS.	DATE	DOI/MOD.
A	05/02/09	DOIxxxx
B	08/04/09	

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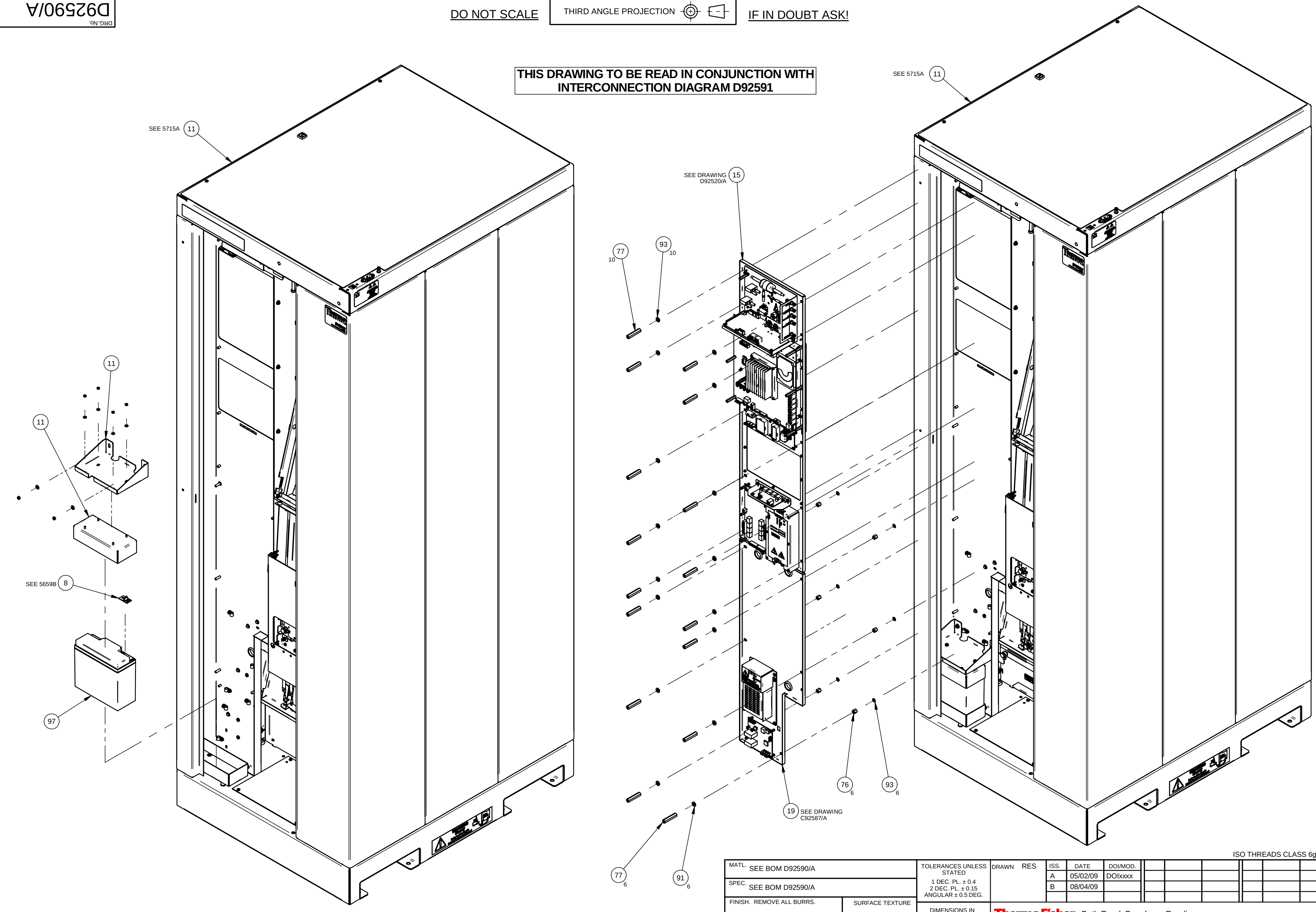
DRG.No. D92590/A

DO NOT SCALE | THIRD ANGLE PROJECTION | IF IN DOUBT ASK!

THIS DRAWING TO BE READ IN CONJUNCTION WITH INTERCONNECTION DIAGRAM D92591



NOTE: SIDE DOOR NOT SHOWN FOR CLARITY

ISO THREADS CLASS 6g/6H

MATL. SEE BOM D92590/A	TOLERANCES UNLESS STATED 1 DEC. PL. ± 0.4 2 DEC. PL. ± 0.15 ANGULAR ± 0.5 DEG.	DRAWN RES	ISS.	DATE	DOI/MOD.	
SPEC. SEE BOM D92590/A			A	05/02/09	DOIxxxx	
			B	08/04/09		
FINISH. REMOVE ALL BURRS. SURFACE TEXTURE √ UNLESS STATED	DIMENSIONS IN MILLIMETRES	ThermoFisher SCIENTIFIC Bath Road, Beenham, Reading, Berkshire, RG7 5PR, ENGLAND.				
	SCALE 1:5	TITLE GENERAL ASSEMBLY - PCM12A	DRG.No. D92590/A	SH 3 OF 3		
MANUFACTURE TO DIMENSIONS SHOWN. FINISHING ALLOWANCE ALREADY DEDUCTED						

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